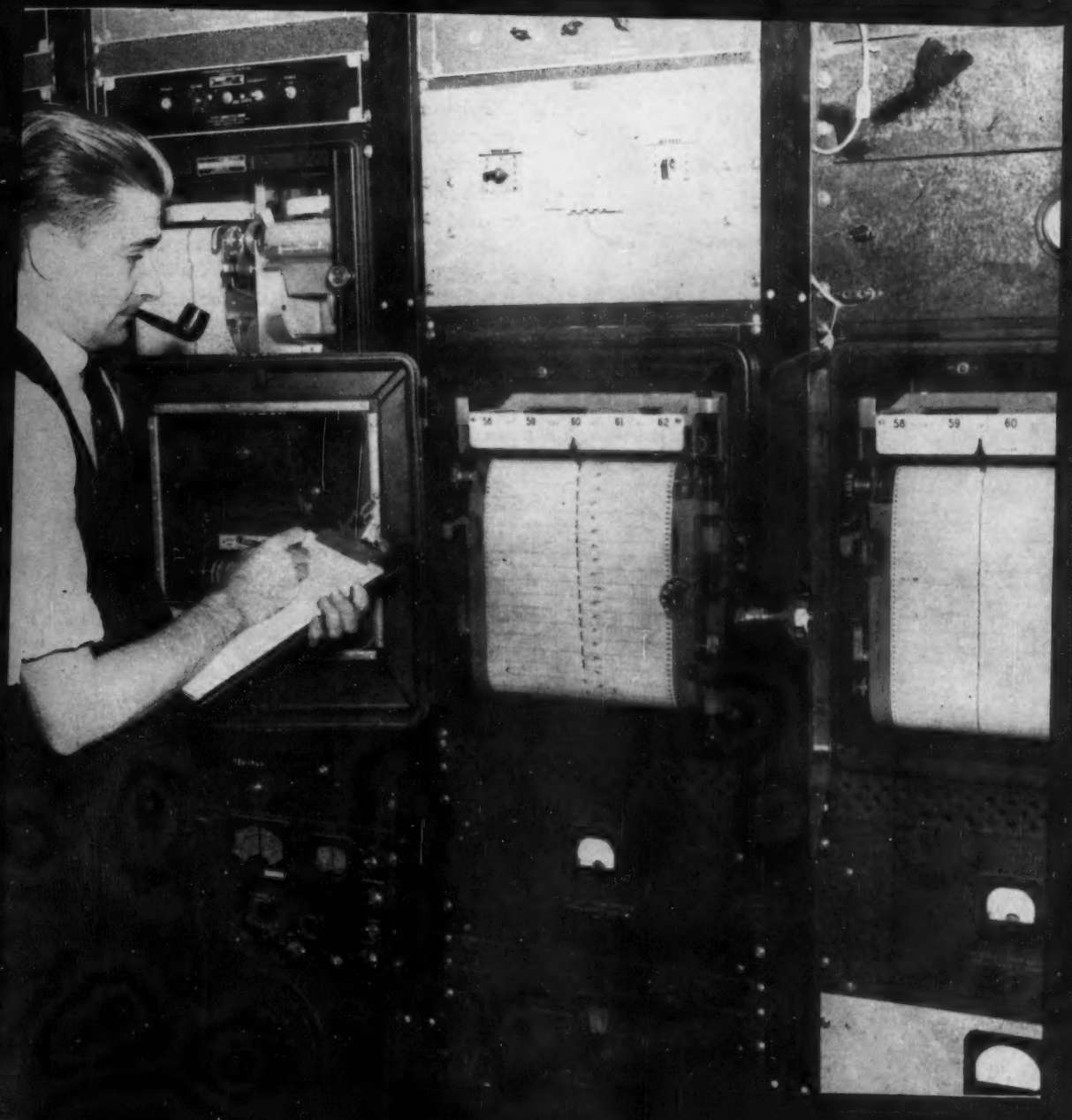
Instruments

HE MAGAZINE of MEASUREMENT and CONTROL

Vol. 21 APRIL 1948 No. 4

cluding the JOURNAL of the Instrument Society of America



Moisture measurement

FOR WOOD AND WOOD PRODUCTS

TAG Moisture Meters

Today, producers of lumber *guarantee* the percentage of moisture content in the products they sell... and lumber dealers, builders and other users of wood and wood products buy or sell on the same firm basis.

Universally accepted and used for rapid, accurate determinations of moisture content in wood, *the TAG-Heppenstall Moisture Meter helps to eliminate costly claims, damage and waste all along the line.* Satisfaction, based upon this MOISTURE PROTECTION is assured before, during, and after fabrication.

The TAG-Heppenstall Meter is entirely self-contained, relatively low in cost and indicates per-cent moisture content by direct-reading. This quick, efficient application dispenses with complicated laboratory tests formerly required by other methods.

Other TAG Moisture Meters are available for quickly determining moisture content in tobacco, grains, and other granular materials. All give accurate moisture measurement... more convenience... lower cost.

for WOOD

for GRAIN

for GRANULAR MATERIALS

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C. J. TAGLIABUE CORPORATION (N. J.)

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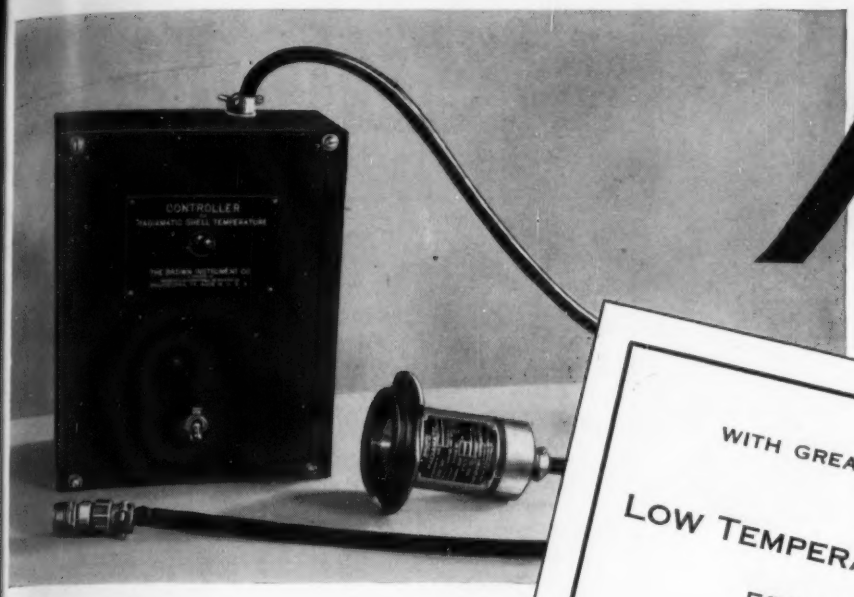


New

WITH GREAT PRIDE WE PRESENT
THE
LOW TEMPERATURE RADIAMATIC
FOR TEMPERATURES
BETWEEN 70 AND 600° F.
AN OUTSTANDING ADVANCE
IN INSTRUMENTATION

The full scope of this new development is unknown. Original installations, however, prove that it opens new horizons in low temperature measurement and control.

Brown pioneers again with the introduction of a practical radiation pyrometer for low temperatures.

The new *Radiamatic* provides a means of controlling low temperature processes where a thermocouple or thermometer bulb cannot be placed in contact with or sufficiently close to the work to obtain reliable readings. It can be used where vibration and shock would damage other temperature measuring means—where work moves or rotates.

Already the new Low Temperature Radiamatic has filled an instrumentation need on plastic mills, rubber mills, plastic finishing rolls, continuous curing ovens and paint pigment kilns. It has also been used in the study of radiating characteristics of surfaces.

PERTINENT POINTS

(1) The instrument is supplied with a 0 to 100 scale. (2) Some customers have successfully used the low temperature *Radiamatic* for temperatures below 70°F., we are now in the process of accumulating such field data for your future benefit. (3) The material being measured must have emissivity which is consistent to within a small percentage of its nominal value. (4) The room temperature surrounding the *Radiamatic* head should always be below 120°F.

WE SOLICIT YOUR INTEREST

Production is limited. However, we solicit your inquiries. This new device may solve an outstanding control problem in your field . . . and solving your control problems is our primary interest.

THE BROWN INSTRUMENT COMPANY, 4482 Wayne Ave., Philadelphia 44, Pa.

DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR CO.

Offices in principal cities of the United States, Canada and throughout the world.

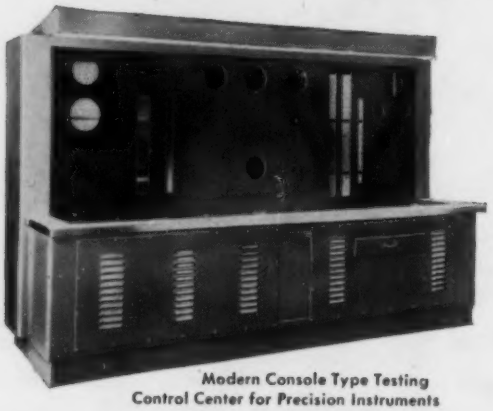
BROWN *Advanced Instrumentation* **FOR BETTER PROCESSING**

Product of MINNEAPOLIS Honeywell

Quality AT A GLANCE

...in a FINE WATCH ...in a

FALSTROM PANEL



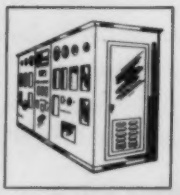
Modern Console Type Testing Control Center for Precision Instruments

A FINE panelboard does much more for the instruments on it than support them properly. Just as the scintillating case of a fine watch points to the worth of the precision movement within it—so the design, smooth lines and custom features of a Falstrom Panel indicate the outstanding superiority of the entire control assembly... *quality at a glance!* Write for illustrated bulletins S125 and S126.

STRUCTURES FOR EVERY CONTROL REQUIREMENT

New Knocked-Down Cubicles

Control Panel with Monitor's Desk



Heavy Duty Public Utility Cubicle

Since 1870
Designers... Engineers... Builders

FALSTROM COMPANY
FALSTROM COURT • PASSAIC • NEW JERSEY

Instruments

Vol. 21 APRIL 1948 No. 4

EDITORIAL 315
Instrumentation Science Can Be Fun

Feature Articles

SIMULTANEOUS MEASUREMENT OF TENSIONAL AND ELECTRICAL RESISTANCE OF FINE WIRES 328
By J. T. Norton and G. C. Kuczynski

A FIFTY-POINT BRIDGE BALANCE UNIT for use with a Baldwin SR-4 Strain Indicator 329
By N. C. Fick and N. A. Crites

SIMPLIFIED DYNAMIC STRAIN EQUIPMENT 330
By Will J. Worley

BIBLIOGRAPHY ON TRANSDUCTORS, Magnetic Amplifiers, etc. 332
Appendix to December article by H. B. Rex

TWENTIETH ANNIVERSARY FEATURE
A "Historical Museum *on* Paper" *of* American Instruments *in* Science *and* Industry
(Concluded)

EDITORIAL INTRODUCTION 334
Eighth "Gallery" 334
The "MIRACLE of PRODUCTION" and VICTORY 1944-1945

The Month's New Instruments 316

Instruments on the March

Shielding Principle Provides Electrical Micrometer 294
AAAS Conference on Instrumentation 296
Unique Instrument Kits 296
Calibration-flasher Control 296
Dyeless Color Microscopy 296

Other Regular Features

LETTER TO THE EDITOR. By G. P. Lonergan 298
WHEN A FELLER NEEDS CONTROL 298
MANUFACTURERS' NEW LITERATURE 376
ADVERTISERS' INDEX 380

***JOURNAL* of the INSTRUMENT SOCIETY OF AMERICA** 365

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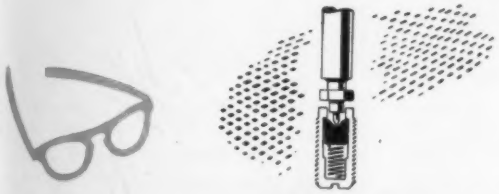
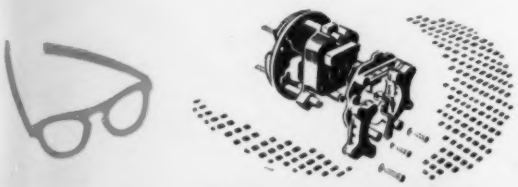
GREATER STRENGTH

FOR EASE AND ECONOMY OF SERVICE



STURDINESS—Jewels spring mounted to minimize possibility of accidental damage to pivots.



EASE AND ECONOMY OF SERVICING assured by new "unit" design . . . entire moving-element assembly can be removed without disturbing calibration.

OTHER POPULAR FEATURES OF THE NEW LONG SCALE LINE ARE—

Reduction of behind-the-panel depth . . . potential circuit resistance built within the instrument in most instances. *Economy of space* . . . small size—only 4¼ inches square—permits mounting of five instruments side-by-side on a panel only 24 inches wide. *1-per-cent accuracy* . . . antiparallax scale and pointer plus antiglare glass permit readings from any reasonable distance or angle.

And those are only a few of the features available to you in these new instruments. Couple them with the many other refinements found in all G-E switchboard instruments and you have a line unexcelled in quality and performance . . . instruments that will do the job better, quicker, and more efficiently.

When you need switchgear or additional switchboard instruments, *insist* on the G-E long-scale line and be *sure* of the best. Ask your nearest G-E sales office for complete information on these AB-15 (a-c) and DB-15 (d-c) instruments. . .

A-c Ammeter	**A-c Voltmeter**	**A-c Wattmeter**
Varmeter	**Power-factor Meter**	**Frequency Meter**
Synchroscope	**D-c Ammeter**	**D-c Voltmeter**

Apparatus Dept., General Electric Company, Schenectady 5, N. Y.

*Reg. U.S. Pat. Off.

GENERAL ELECTRIC

602-116

INSTRUMENTS ON THE MARCH

Shielding Principle Provides Electrical Micrometer

WASHINGTON, D. C. — The principle that the field surrounding a coil fed with alternating current will induce current in an adjacent coil and that the amount of current thus induced can be controlled by placing a shield or a low-resistance conductive medium at various distances from the latter coil, is employed to make a linear reading device for use as an electrical micrometer. The shield is placed not between the primary and secondary coils, but adjacent to the latter. Its distance from the secondary coil determines the amount of energy produced in this coil.

The new device, developed by M. L. Greenough of the National Bureau of Standards, was primarily designed to afford a means for measuring thickness of the oil film in the bearings of a large Navy turbine shaft. The device has a number of important applications: as a micrometer, a phonograph pick-up, a microphone, etc.

The electrical micrometer designed at the Bureau utilizes the fact that high-frequency energy radiated from a coil is at zero at the surface of a perfectly conducting shield adjacent to that coil. This phenomenon occurs because eddy currents are set up in the shield by the field of the radiating coil, and these eddy currents set up an opposing magnetic field at the surface of the shield. The opposing field exactly cancels the incident field at the surface of the metal plate. Theoretically, a pick-up coil of zero thickness applied at the surface of the shield would receive no energy. Since it is impossible to design a coil of zero thickness, compensation for the necessary thickness has been included in the design.

When the pick-up coil is moved away from the shield, in the direction of the radiating coil, it picks up a certain amount of energy because the radiated field becomes stronger while the field set up by the currents of the shield becomes weaker due to the change in distance. This condition becomes more marked as the distance between the pick-up coil and the shield increases. This is true whether the distance between the pick-up coil and the radiating coil decreases or remains unchanged.

Because the metal background is not a perfect conductor and because the coil has a measurable thickness, a minimum reading is obtained when the pick-up coil is in contact with the metal background. This condition is corrected by the addition of a third coil which permits a zero reading to be obtained.

The radiating coil is fed a high-frequency current. When the micrometer is held at some distance from any metallic object, the field from the radiating coil induces voltage in the secondary (or pick-up) coil, and this induced voltage is measured either on an oscilloscope or by an a-c. indicating instrument, which indicates the change in distance between the micrometer and the metal background.

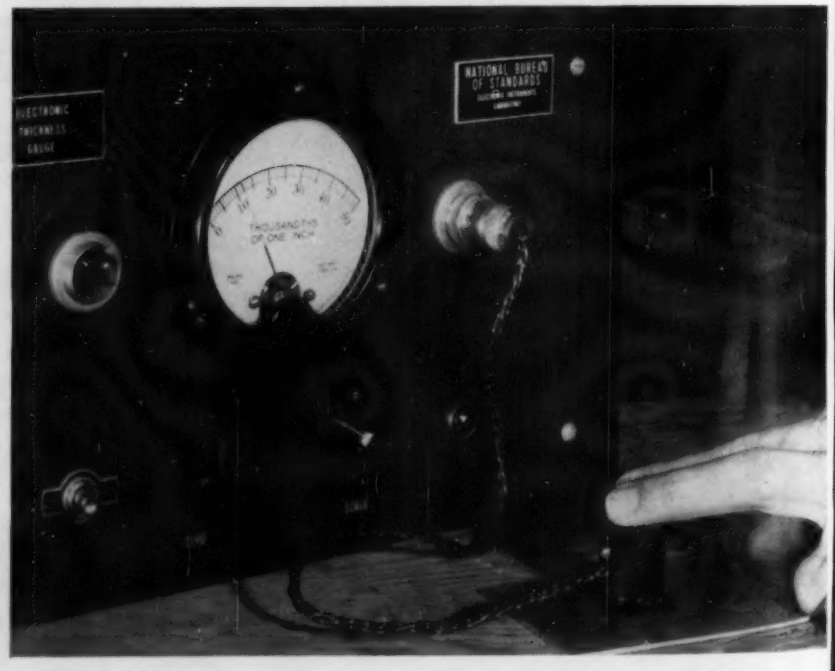
This principle can be employed in a variety of ways. In its application as a micrometer, the coil assembly is mounted on a movable shaft in such manner that it can be caused to approach or recede from a metallic plate. The material to be measured is placed between and is pressed lightly between them. When the material is removed, the current generated in the pick-up coil is a the pick-up coil and the metallic plate measure of the thickness of the material which occupied the space. The indicating instrument can therefore be calibrated in thousandths of an inch.

Capacitance micrometers, with which measurement is made of the thickness of a non-conducting film separating the micrometer from a conductive background, are well-known. It is impossible, however, to use micrometers of this type where the conductive background is either inaccessible or cannot be accurately defined. Similarly, inaccuracies are likely to be introduced because of changes in the dielectric constant of the insulating film covering the metallic backing.

When the new electrical micrometer was used to measure the displacement of a turbine shaft in its journal, four of the devices were spaced equally around the turbine shaft. This arrangement is so sensitive that a deflection of 0.01″ of the center of a 6″ shaft provides a 2″ deflection of the center spot of a cathode-ray tube. The micrometer is about ½″ in diameter by ¼″ in length and is able to measure distances from zero to 0.02″. Readings to 0.0001″ are easily obtained. The indication is linear to within a fraction of one percent.

When the principle is employed in a phonograph pick-up, the vibration of a flat-plate armature fastened to the needle causes a change in the position of this armature with respect to the pick-up coil. This causes alternation in the output of the pick-up coil, and these electrical fluctuations may be rectified and fed into an amplifier for reproduction. By selection of suitable frequencies, the output of the pick-up coil may be high frequency fed directly into the intermediate frequency stages of a superheterodyne phonograph-radio receiver in any of a variety of ways. Tests of the circuit indicate satisfactory operation in receivers using a 450-kilocycle intermediate frequency.

When the new electrical micrometer is used as a microphone, vibrations adjacent to the pick-up coil are created by a metallic diaphragm, and the movement of this diaphragm causes fluctua-



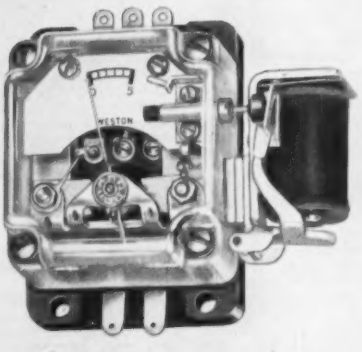
Measuring paint-spot thickness with new NBS micrometer

This WESTON [MODEL 813] **Sensitrol Relay*

- **provides positive control on 2 microamperes**
- **handles up to 50 milliamperes at 120 volts AC or DC**
- **resists extreme shock and vibration**

Here is a sensitive relay whose unique characteristics stir the imagination... suggesting to design engineers vast possibilities for *new* product development, and for simplification and improvement of existing products. To assist in their proper application, consult our representatives, or write... WESTON Electrical Instrument Corporation, 591 Frelinghuysen Ave., Newark 5, New Jersey.

**SENSITROL—A registered trade-mark designating the contact-making instruments and relays, as manufactured exclusively by the Weston Electrical Instrument Corporation.*



Solenoid reset type (illustrated directly above) or manual reset types available.

WESTON *Instruments*

ALBANY · ATLANTA · BOSTON · BUFFALO · CHARLOTTE · CHICAGO · CINCINNATI · CLEVELAND · DALLAS · DENVER · DETROIT · JACKSONVILLE · KNOXVILLE · LITTLE ROCK · LOS ANGELES · MERIDEN · MINNEAPOLIS · NEWARK
NEW ORLEANS · NEW YORK · PHILADELPHIA · PHOENIX · PITTSBURGH · ROCHESTER · SAN FRANCISCO · SEATTLE · ST. LOUIS · SYRACUSE · IN CANADA, NORTHERN ELECTRIC CO., LTD., POWERLITE DEVICES, LTD.

tions in the output of the pick-up coil. The action is similar to that of the device used as a phonograph pick-up. With a slight modification, the device may be used as a thermometer. A strip of bimetal of convenient length is so mounted that it extends in a path parallel to the end plane of the pick-up coil, positioned closely adjacent to that coil. As the bimetal bar bends in accordance with heat, its free end is brought closer to or farther from the pick-up coil and an indication is given on an instrument calibrated in degrees.

AAAS Conference on Instrumentation

KINGSTON, R. I.—The Gordon Research Conferences sponsored by the AAAS (formerly known as the Gibson Island Research Conferences) for 1948 will be held from June 21 to September 3 at the Colby Junior College, New London, N. H., it was announced by Conference Director W. George Parks, Rhode Island State College, Kingston, R. I.

Those interested in attending the Conferences are requested to send in their applications to the Director, on or before April 20. Each applicant must state the institution or company with which he is connected and the type of work in which he is most interested. Attendance at each Conference is limited to 100 individuals. Members attending a Conference are expected to live at the College.

The morning sessions, Monday through Friday, are scheduled from 9:30 to 12:00 noon. The second session of each day is held in the evening from 7:30 to 10:00 p.m., Monday through Thursday. There are no Friday evening sessions.

August 2-6—INSTRUMENTATION—J. C. PETERS, Chairman; H. C. FROST, Vice-Chairman.

August 2. *Chemical Analysis Through Dielectric Constant Measurements.* Speaker to be announced. Methods for Measuring Dielectric Constant. Speaker to be announced. Solution of Analysis Problems with Dielectric Constant Measurements.

Instrumentation in Modern Radio Chemistry. Speaker to be announced. Instruments Used for Measuring Radioactivity. CLIFFORD K. BECK. "Tagged Atom" Analytical Techniques and Applications.

August 3. *Application of Microwaves to Instrumentation.* Speaker to be announced. Basic Concepts of Microwaves as Applied to Instrumentation. Speaker to be announced. Solution of Measurement Problems with Microwaves.

Use of Ultrasonics in Chemical Analysis. Speaker to be announced. Recent Developments in Application of Ultrasonics to Chemical Analysis.

August 4. *X-ray Absorption Spectroscopy.* H. W. BOUSMAN. Physical Analysis by X-ray Absorption Techniques. Speaker to be announced. Continuous Measurement of Process Variables with X-ray Absorption.

Symposium on Problems Associated with the Development of Instruments for Research and Process Measurement and Control. Speaker to be announced.

August 5. *Raman and Ultraviolet Spectroscopy.* E. J. ROSENBAUM. Raman Spectroscopy.. A. O. BECKMAN. Applications of Ultraviolet Spectrophotometry.

Electrical Methods of Analysis. Speaker to be announced.

August 6. *Measurement of Gas Concentration.* O. G. KOPPIUS. Infrared Product Controller.

Unique Instrument Kits

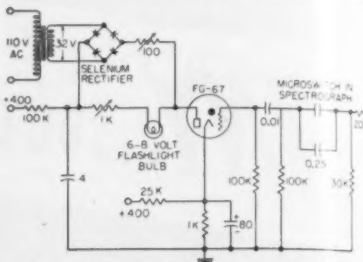
PITTSBURGH, Pa. — In the Mid-Continent oil fields another engineer saw Nick Rebarick, field engineer for the Spang-Chalfant Division, National Supply Co., moving on a job with his new black kit and remarked to a

friend: "There goes a walking 'Bureau of Standards'." This was not said in jest, for Nick, like the three other field engineers of Spang-Chalfant who investigate complaints in the oil fields under the direction of Chief Engineer Howard Texter, is not only an expert in his own right, but he carries a variety of testing and measuring instruments that would be the delight of any laboratory technician—instruments that cost approximately $3500.00 — instruments to meet any emergency that might arise out on a field job or in a machine shop relative to tubular products.

Calibration-flash Control

NEW YORK, N. Y.—A thyratron-controlled calibration flasher designed to eliminate variations in the intensity and width of recorded reference lines when spectra are recorded photographically at different speeds is shown in the attached circuit diagram released by The Texas Company. Closing of the microswitch fires the thyratron which discharges the 4 mfd. capacitor through a small incandescent lamp filament.

The magnitude and duration of the current wave produced by each capacitor discharge will be the same regardless of changes in the flashing rate. But an increased flashing rate will tend to increase the starting temperature of a lamp filament excited solely by the discharge and increased flash intensities will result.



Circuit diagram of the thyratron-operated calibration flasher

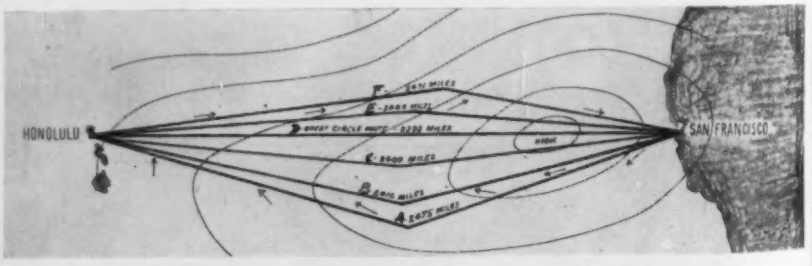
Filament starting temperature is corrected by means of a small direct current provided by the transformer, full-wave rectifier and series resistance. D.c. excitation of the lamp is desirable since flashing will occur at different phases of an a-c. wave and reference lines of varying intensity will result.

Dyeless Color Microscopy

CHICAGO — Microscopy in color, without the use of dyes or light filters, is now a reality. A new technique, developed by Germain C. Crossmon, Bausch & Lomb Optical Co. scientist, provides a speedier, more accurate identification of a wide range of colorless, transparent substances, including drugs and minerals.

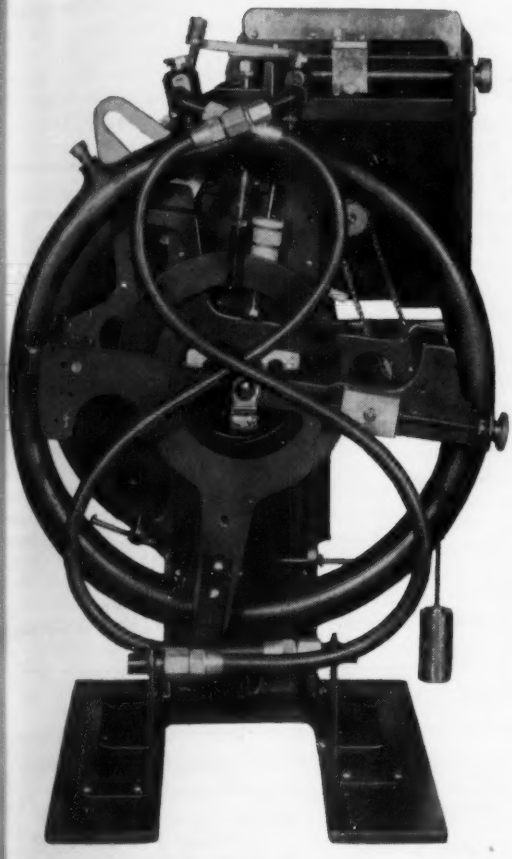
In a talk delivered here before the Zooligical Section of the AAAS, Crossmon termed the technique "dispersion staining" and showed color photographs of thin sections of body tissue in which muscle fiber, blood vessels and fatty tissues appeared in bright contrasting colors.

Crossmon demonstrated that only standard microscope equipment is required to turn transparent, colorless ob-



NEW USE FOR RADAR ALTIMETERS. United Air Lines pilots flying between San Francisco and Honolulu use "pressure pattern" route selection made possible by (1) accurate meteorological data before and during trip, (2) efficient navigation, (3) constant interchange of information by radio, (4) pressurized cabins of DC-6 type transports permitting flying at 20,000 feet. Comparison of readings of high-altitude radar altimeters and pressure-type altimeters enables navigator to plot pressure area altitude and take advantage of favorable winds. In a situation such as shown on the above map, the fastest westbound route would be A and the fastest eastbound route would be F—instead of D which is the shortest.

Fewer Meter Types Needed



when you standardize on Hagan Ring Balance

Upper left: Standard meter body equipped with R 80 ring, for differential pressures from 20 to 140 inches. Ring R 22 (bottom) is for maximum differentials from 0.5 inch to 4 inches; R 91 (top) from 60 to 420 inches. Other rings are available for other differentials. Adjustment for various differentials within each range is merely a matter of setting a range screw.

With Hagan Ring Balance Flow Meters, any given meter can be adjusted in the field to give full scale reading for any differential within a range of 7 to 1.

Adjustment within this range is obtained by merely changing the setting of a range screw. The meter is quickly recalibrated by means of check weights furnished with it, and is back in service within a few minutes. No piping need be disconnected.

Since for any meter job within this 7 to 1 range only one meter body is required, you can carry in stock the meters you are likely to want. There is no need to wait for a 'tailor-made' job.

This easy adaptability to a wide variety of applications is one reason why more and more plants are standardizing on Hagan Ring Balance Meters.

For full information, send for Hagan Bulletin 2M47.

Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN CORPORATION

HAGAN HALL BUROMIN CALGON

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

WHY BUY
3 UNITS
when
1 TWIN SEAL UNIT
WILL SERVE 3 WAYS

10,000 psi—no leakage or seepage

1 PORTABLE PRESSURE TESTING
Weight, filled with oil, 8½ lbs.

2 BENCH WORK WITH TEST GAGE
mounted on aluminum drip pan

3 DEAD WEIGHT TESTING
shown with dead weight attachment mounted on unit.
Write for Bulletin

MANSFIELD & GREEN
1051 Power Avenue CLEVELAND 14, O.

jects to bright colors. By choice of the correct immersion liquid which is placed over the sample, each different material appeared a different color. Crossmon illustrated his technique with photographs: In each case, particles of different composition were different in color.

To make white light on a colorless object produce color, Crossmon pointed out, the light from the microscope lamp is passed through a darkfield substage lens to strike the sample at a high angle. The sample is covered with a high-dispersion liquid that matches the refractivity of different materials at different portions of the color spectrum.

Each material then scatters some of the colors present in the white light into the microscope where they are seen by the observer while other colors pass directly through the sample at such a high angle that they do not enter the microscope.

The new method is expected to increase use of the microscope in checking foods or drugs for adulteration or contamination; testing minerals or ores for impurities and textiles for fiber identification; determining identity of fragments in crime laboratories; studying the relative refractive index of body tissue structures in medical microscopy. Use of dyes to stain tissues or bacteria probably will not be supplanted, Crossmon stated, in those cases where absorption of the dye is a specific chemical identification of the material.

In all of the many cases where a mixture of transparent materials is to be studied with a microscope, the color contrast produced by "dispersion staining" is expected to make the work of the microscopist less arduous.

LETTER

To the Editor of *Instruments*:

I would like to correct the statement made in the writeup published in the January 1948 issue of *Instruments* on page 41 in which I stated that the mercury-type flowmeter developed by The Bristol Company in 1909 was the first to be built in this country.

Mr. Charles G. Richardson of Builders-Providence, Inc. has advised me that F. N. Connet, Chief Engineer of Builders until his death, developed a mercury-float instrument in 1893 with assistance from Walter W. Jackson. This instrument was known as the Venturi Meter Register, and was installed first in New Jersey Water Works System, Newark, N. J. in 1893.

G. P. LONERGAN
The Bristol Co.

WHEN A FELLER NEEDS CONTROL

By Phil Putnam

THE PROJECT ENGINEER GIVES THE INSTRUMENT ENGINEER HIS MINIMUM REQUIREMENTS
NOW HERE WE MUST CONTROL FLOW WITHIN ±1%, PRESSURE WITHIN ± ½ PSI AND TEMPERATURE WITHIN ± ½°F. ALL WETTED PARTS TO BE STAINLESS. BUDGET ALLOWANCE IS $500.00
BUT MIKE — THAT CAN'T BE DONE FOR LESS THAN $1,000.00! MIGHT EVEN GO TO $1,500.00!
WHAT! ALL YOU INSTRUMENT MEN WANT TO DO THINGS TOO EXPENSIVELY — WELL, I'LL DO THIS JOB AND SHOW YOU HOW!
SO-HE DOES THE JOB HIMSELF — HOW THOSE REQUIREMENTS CHANGE!
YEAH, MIKE, I SURE DO SEE
SEE! I TOLD YOU WE COULD DO IT! WELL YES, WE DID USE CAST IRON AND BRONZE. CONTROL? WELL WE ARE HOLDING WITHIN ±2% ON FLOW, AND ±2 PSI ON PRESSURE, AND ± 3° NOT QUITE WHAT WE WANTED, BUT IT WILL DO!
IDEA BY:
R.B. TURKINGTON
ENG DEPT.
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LANCASTER, PA.

Instruments pays $5.00 for each idea used. Sender's name and company affiliation will be acknowledged in the cartoon unless we are specifically requested not to do so. Address Cartoon Dep't, *Instruments*, 1125 Wolfendale St., Pittsburgh 12, Pa.

INSTRUMENTATION (THE SCIENCE) CAN BE FUN

By M. F. BEHAR

IN our February 1942 issue there was shown on this page a tabular mapping* of the entire realm of Instrumentation. The editorial ended with a "teaser":

> There is published for the first time one of the basic formulae which I developed between 1924 and 1927, when I had to prove that the formulation of a new science, to be called "Instrumentation," was not a wild dream but a useful project. This formula needs a key. The key (one word to the wise) is Methodology.

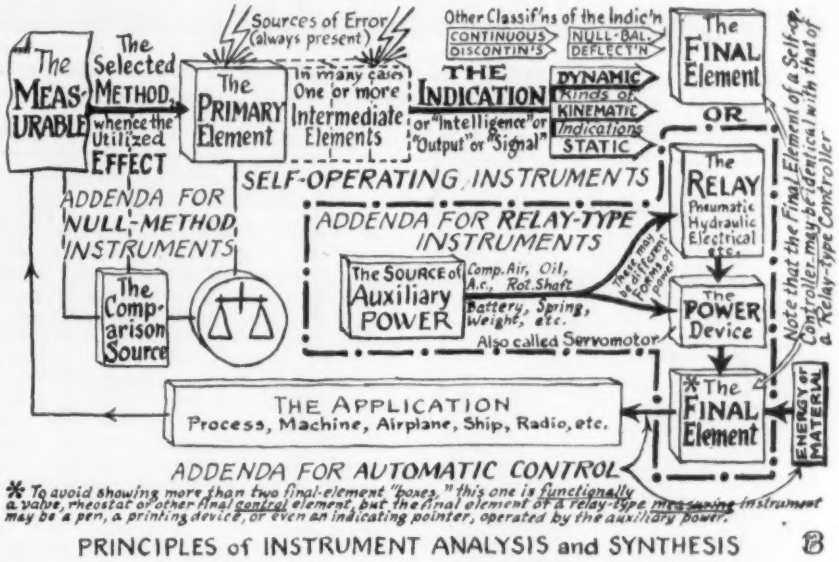
That being considered a dry** subject in 1942, most of those who showed a spark of interest were the few who had not yawned or laughed when the first Instrumentation lantern-slides and blackboard sketches had been falteringly, hesitantly and clumsily expounded some two decades ago.

These few enthusiasts have become well-known in Instrumentation circles; some becoming Research Directors, Chief Engineers, etc.; becoming also good teachers and writers in their special fields of the vast realm of Instrumentation—for they, too, discovered the thrills of Analysis, the fun of Methodology, the joy of constructing Perfect Classifications.

Thanks largely to their missionary zeal, the new generation (90% of you who read this) will not ridicule Methodology but will take to it. The time has come for publishing more of the basic graphs shown heretofore to small audiences only. Here are three more. (Two of them were touched up in recent years, because their first forms and wordings betrayed the clumsiness of the pioneer.) That they will please a 1948 audience was recently demonstrated.

With the general map and these three slides, you *might* enjoy a long lecture or article on "The Methodological Foundation of Modern Measurement and Control"—but you *will* enjoy much more the fun of composing such a lecture or text in your own words!

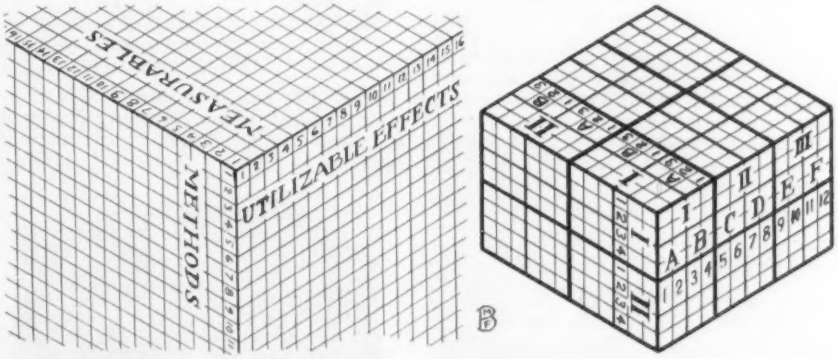
Go to it!


The MEASURABLE
The Selected METHOD, whence the Utilized EFFECT
Sources of Error (always present)
The PRIMARY Element
In many cases One or more Intermediate Elements
THE INDICATION or "Intelligence" or "Output" or "Signal"
Other Classif'ns of the Indic'n
CONTINUOUS DISCONTIN'S
NULL-BAL. DEFLECT'N
DYNAMIC Kinds of KINEMATIC Indications STATIC
The FINAL Element
OR
The RELAY Pneumatic Hydraulic Electrical etc.
The POWER Device
The FINAL Element
ENERGY or MATERIAL
Note that the Final Element of a Self-op. Controller may be identical with that of a Relay-type Controller
SELF-OPERATING INSTRUMENTS
ADDENDA FOR NULL-METHOD INSTRUMENTS
The Comparison Source
ADDENDA FOR RELAY-TYPE INSTRUMENTS
The SOURCE of Auxiliary POWER
Comp. Air, Oil, A.c., Rot. Shaft
Battery, Spring, Weight, etc.
These most of different forms of power
Also called Servomotor
THE APPLICATION
Process, Machine, Airplane, Ship, Radio, etc.
ADDENDA FOR AUTOMATIC CONTROL

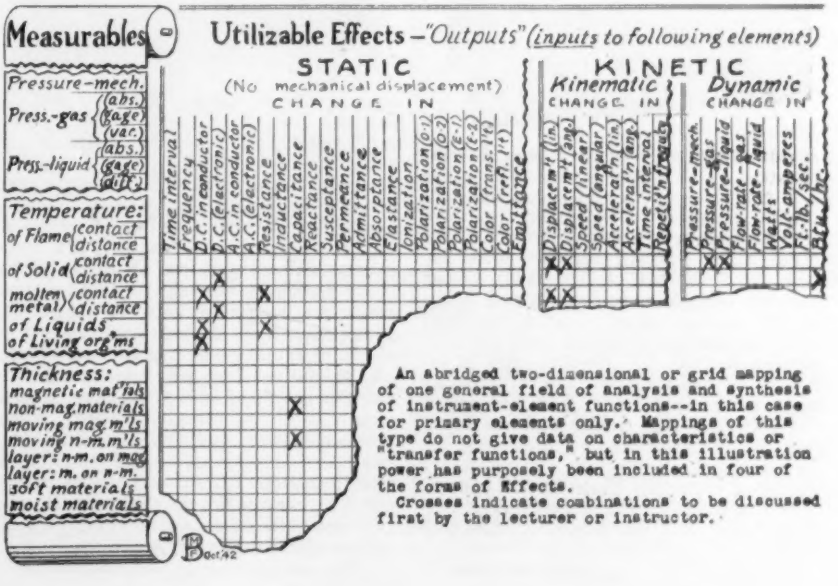
* To avoid showing more than two final-element "boxes," this one is functionally a valve, rheostat or other final control element, but the final element of a relay-type measuring instrument may be a pen, a printing device, or even an indicating pointer, operated by the auxiliary power.

PRINCIPLES of INSTRUMENT ANALYSIS and SYNTHESIS

You can have fun constructing for yourself this type of formula or mapping; and more fun expounding it to others. Especially fascinating is the game of Permutations and Combinations, even if you play it only with tangible Elements and leave out abstract factors. For a vivid example, see *Instruments*, July 1930, pages 439-440, where a simple game of Combinations, played with the relatively few types of elements then available, yielded "believe-it-or-not" products.



"LEFTIST CHAOS OR RIGHTIST ORDER?" is *one* way you could introduce this type of presentation. (It depends on your audience!) Purpose is twofold: (1) the combinations already run into the millions and every new Effect, Element, etc., produces hundreds or thousands of new "boxes"; (2) the Method replaces each wildly-growing list by a permanent Perfect Classification, which is a classification into *collectively-exhaustive* and *mutually-exclusive* categories. Thus is loose know-how organized into a fruitful science yielding more know-how.



An abridged two-dimensional or grid mapping of one general field of analysis and synthesis of instrument-element functions--in this case for primary elements only. Mappings of this type do not give data on characteristics or "transfer functions," but in this illustration power has purposely been included in four of the forms of Effects.

Crosses indicate combinations to be discussed first by the lecturer or instructor.

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*First column, a Perfect Classification of measurables; second column, various Perfect Classifications of methods; etc. It was printed again in the November 1945 issue, page 754, where you can look it up more readily. Besides, you can construct your own "General Map." Furthermore, the three graphic presentations shown here are much more fun!

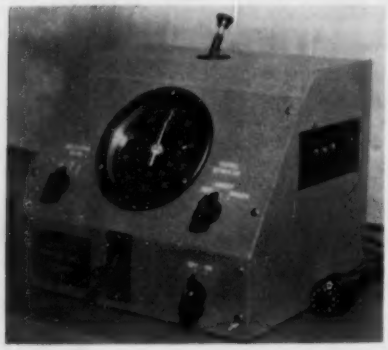
**The ending "-ology" was (and is) a handicap. This was ONE reason why "Instrumentology" was rejected in 1924-28 as the name of the new science.

The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions.
FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 379

Visual Reaction Timer

New "No. 23307 Selective Visual Reaction Timer," designed for use by Personnel Departments and psychologists,

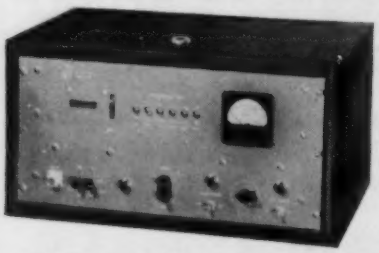


comprises a control cabinet (illustrated) with 0.01-second-interval timing clock and all master controls; a reaction keyboard with three keys numbered 1-2-3 to agree with three-point selector switch; "light stimulus" panel with red, amber and green lights. Equipment operates on 115-volt 60-cycle a.c.—*C. H. Stoelting Co., 424 N. Homan Ave., Chicago 24, Illinois.*

Please mention number 401 when filling out card

Scaler for Beta-particles and Gamma-rays

New "Model 165" scaler for counting beta particles and gamma rays completes a line of similar instruments,



providing one with built-in register and operated by Higinbotham scaling circuits that have proved their reliability in wide usage. It operates on impulses from a Geiger-Mueller counter which actuates the built-in register once for each 64 impulses it receives. Other features include a self-contained high-voltage supply which can be provided for a maximum of either 1500 or 2500 volts as desired. No pre-amplifier is required for use with the Geiger-Mueller tube. Internal circuit has an input sensitivity of 0.25 volts, and resolving time is better than 5 microseconds. High-voltage supply is electronically regulated to better than 0.01% change in line voltage. — *Instrument Development Labs., 223 W. Erie St., Chicago 10, Ill.*

Please mention number 402 when filling out card

Pressure Switch

New "Model 410" Switch, designed for numerous low-pressure and vacuum applications in the aircraft and other industries, is of tamper-proof design, yet loosening of sealed lock ring permits convenient adjustment. Available in many combinations of diaphragm and switch elements, "Model 410" permits a wide selection of operating, proof and pressure differentials. A manual reset feature is embodied when desired. Among features: weight less than 10 ounces; ambient temperature operation from –65°F. to 170°F.; explosion-resistant; differentials 3″ or more of water; proof pressures as high as 150 lbs./in.^{2}; operating range from 4″ of water to 100 lbs./in.^{2}; will withstand total vacuum; is protected against atmospheric corrosion.—*Meletron Corp., 952 N. Highland Ave., Los Angeles 36, Calif.*

Please mention number 403 when filling out card

"64" Scaler

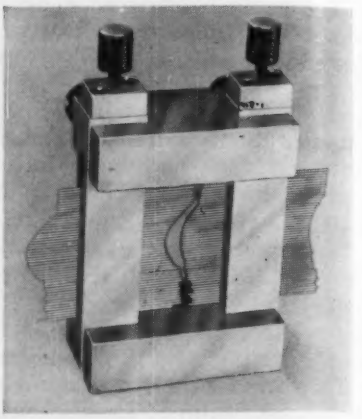
New "64" Scaler is said to be a complete scaling unit with many features previously unobtainable in commercial scalers. It uses "Duoscale" plug-in

scaling unit incorporating Higginbotham circuit, which permits easy replacement of defective scaling circuits and greatly simplifies servicing. A scale selector switch allows output of any scale from 8 to 64 to be connected to driver amplifier for panel-mounted counting register. Six neon interpolating lights are mounted behind clear Lucite scale selector dial. Provisions are made on back of scaler for connection of a standard electric stop-clock, such that clock is turned off and on at same time as scaler counting circuit. Included is a G-M tube plug-in mount and universal adapter. High-voltage power supply is continuously variable between 600 and 1800 volts with less than 0.025% change in output per 1% change in line voltage. Resolving time <5 μsec. —*Tracerlab Inc., 55 Oliver St., Boston 10, Mass.*

Please mention number 404 when filling out card

Contour Transfer Gage

New Contour Transfer Gage can be used for measurements of radius or contour where other standard measur-

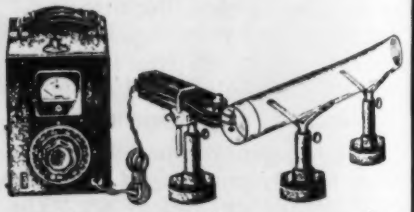


ing devices are not applicable; can be applied to checking die cavity contours and production line parts. In conjunction with an optical comparator, it permits a simple set-up for checking dimensions. A dial indicator or height gage can readily be used if desired. All pins in gage are sized within 0.0002″.—*Accessories and Parts Div., Thompson Products, Inc., Cleveland 17, Ohio.*

Please mention number 405 when filling out card

Glass Tubing Cutter

New "Even Heat Glass Tubing Cutter" utilizes an old method (hot wire) but has refinements said to make it



capable of producing rapid, uniform results. Glass tubing up to 7½″ OD can be cut in any position, as a separate piece or as part of apparatus already set up. Adjustable supports are provided for hot wire cutting unit and for tubing when individual pieces are to be cut, but cutting unit can be used in any position when detached from its support. A foot switch is available as an accessory when operator wants to have both hands free. Special power unit enables operator to balance electrical output with variable wire length. Another feature is elimination of electrical shock hazard: hot cutting wire carries low voltage which is isolated and insulated from power line.—*Eberbach & Son Co., 200 E. Liberty St., Ann Arbor, Mich.*

Please mention number 406 when filling out card

Scaler Conversion Kit

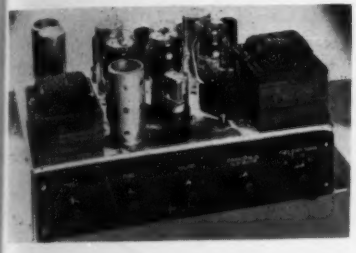
New "Model 3011" kit will convert any IDL manually-operated scaler into one providing automatic count and scale

selection; contains all parts to be added, as well as complete instructions for installing these parts. Company also announces that if scaler is returned to the factory it will be converted for a small additional charge. — *Instrument Development Labs., 223 W. Erie St., Chicago 10, Illinois.*

Please mention number 407 when filling out card

Sound Laboratory Amplifier

New "Type 210-A Laboratory Amplifier," supplied with a matched variable reluctance pick-up cartridge, is said to provide a complete phonograph system



except for turntable or record changer and loudspeaker. It provides 20 watts output with less than 2% distortion. (Below 8 watts, distortion is under 0.5%.) Output transformer is arranged to match speaker impedances between 2 and 500 ohms. Maximum frequency range exceeds 20,000 cycles. With Dynamic Noise Suppressor, response is flat to 10,000 cycles and extends to 16,000 cycles. Independent tone controls allow boost or attentuation at either end of frequency range.—*Dep't I, Hermon Hosmer Scott, Inc., 385 Putnam Avenue, Cambridge, Mass.*

Please mention number 408 when filling out card

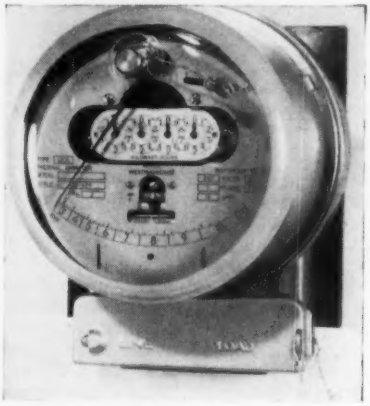
Shock-resistant Electron Tubes

New "Special Red" small-type tubes, 5691, 5692 and 5693 are designed for applications requiring at least 10,000 hours life, exceptional uniformity and stability of characteristics, and rigidity to resist shock and vibration. (Their counterparts in the receiving-tube line are 6SL7-GT, 6SN7-GT, and 6SJ7.) They are said to be capable of withstanding impact shocks of 100*g* for extended periods. Distinctive appearance: glass-octal types 5691 and 5692 have red bases; metal type 5693 has both a red base and a red envelope.—*Tube Dep't, Radio Corporation of America, Harrison, N. J.*

Please mention number 409 when filling out card

Thermal Ampere Demand Meters

New "Type QCA" combination watthour and thermal ampere demand meters are low-cost compact units that can be used by utilities on single-phase or polyphase systems for certain types of industrial and commercial installations where kva. demands are incorporated into rate. They are not intended

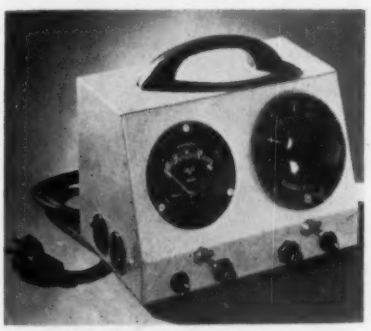


for larger industrial metering. Ampere demand is measured by heating bimetallic elements with current-carrying heaters. Readings can be converted to kva. demand by multiplying by a constant assumed voltage. (In many cases, rate structures are such that accuracy of this approximation is adequate.) Five types are available: "QCA" for single-phase service; "QCA-2" for 3-phase, 3-wire service; "QCA-5" for networks consisting of two phases and neutral of a 3-phase, 4-wire service; "QCA-7" for 3-phase, 4-wire delta service; and "QCA-8" for 3-phase, 4-wire wye service. — *Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.*

Please mention number 410 when filling out card

Variable Voltage Supply

New "Portavolt" voltage control unit is completely self-contained; measures 9″ × 8″ × 7″; contains a 405-watt variable auto-transformer and a 0-150



voltmeter. Input rating is 115 volts, 50-60 cycles, single phase. Output is variable from 0 to 135 volts. Maximum current capacity is 3.0 amperes. Four plug-in load receptacles eliminate need for tedious wiring jobs: each pair of plug-ins is controlled by a toggle switch, has a separate pilot light to signal when load circuit is on, is protected by an easily-accessible cartridge type screw-in fuse. Unit comes ready to operate.—*Andrew Technical Service, 111 E. Delaware Place, Chicago 11, Ill.*

Please mention number 411 when filling out card

Laboratory Rotameter Kit

New rotameter type Laboratory Kit, said to be versatile and inexpensive, meets varied flow measurement requirement of laboratories. It consists of a

unique metering tube holder with base plate and hose connectors, four readily-interchangeable tubes and six metering floats complete with calibration data. Capacities from 0.065 to 2200 cc./min. of water and 5.0 to 36,800 cc./min. of air.—*Fischer & Porter Company, Dept. 5C-J, Hatboro, Pa.*

Please mention number 412 when filling out card

Thermometer-bulb Fittings

New compression type fittings represent a new method of adapting such fittings to thermometer bulbs, enabling users to change thermometers origi-

nally made with plain bulbs to union connection. Compression fittings are applied directly to the bulb to produce any desired length up to 6″. A separable socket may also be provided by welding or soldering a well to the union bushing. With this new method of bulb application, users may keep their thermometers available and install them wherever necessary by simply applying compression fittings in manner dictated by needs of service.—*Manning, Maxwell & Moore, Inc., Bridgeport, Conn.*

Please mention number 413 when filling out card

Bridged-T Attenuators

New "Series 420-OBO" small attenuators are 20-step bridged-T units measuring 2⅛″ in diameter, said to be ideal for use as mixer or master gain controls. Attenuation characteristic is essentially flat from 30 to 15,000 cycles. Attenuation in "off" position is said to be 100 db or better. All resistors are noninductively wound and sealed against moisture and shock. — *Shallcross Mfg. Co., Collingdale, Pa.*

Please mention number 414 when filling out card

Multiple-range Electrical Tester

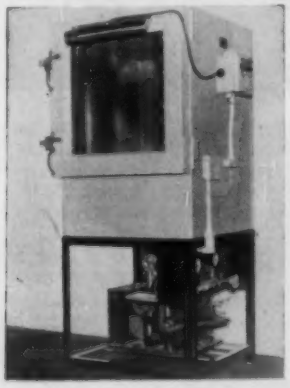
New "Model 2405-A Volt-ohm-milammeter" is said to be a "perfect combination" ultrasensative 20,000 ohms-per-volt d.c., multi-range, 6" instru-

ment with long, easy reading scale, 35 ranges include voltages to 1000 d.c. at 20,000 ohms volt and a.c. at 1000 ohms volt; d.c. current ranges from 0-50 micro-amperes to 10 amps.; a.c. amps to 10; decibels −10 to +55; output and capacitor tests. Plug-in precalibrated rectifier simplifies replacement; "OHMS ADJUST" provides adjustment for all resistance ranges with maximum accuracy. "Square-line" metal case with detachable, hinged cover for portable or counter use.—*The Triplett Electrical Instrument Co., Bluffton, Ohio.*

Please mention number 415 when filling out card

Temperature and Humidity Chamber Laboratory

New self-contained laboratory testing unit has facilities for accurately controlling temperature and relative humidity within a working chamber hav-

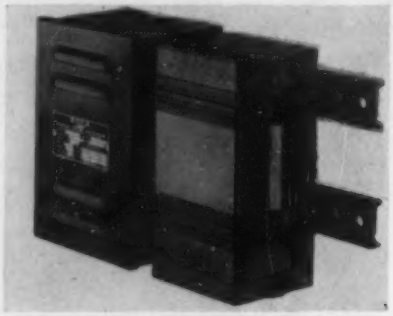


ing a clear space 18" × 18" × 18". Temperature can be varied over a range from 20 to 200°F. (extension of this range available). Maximum rate of temperature change is 20°F. per minute. Relative humidity can be controlled above or below ambient, at a minimum wet-bulb temperature of 33°F. Versatility of control is facilitated by conveniently-located independent switches for heating, cooling, humidifying and de-humidifying circuits; and inclusion of an air-flow damper to proportion air-flow through heating and cooling compartments.—*Tenney Engineering, Inc., 26 Avenue B, Newark 5, N. J.*

Please mention number 416 when filling out card

Constant-voltage Transformers

New "Type CVH" constant-voltage transformers deliver a constant output voltage having low harmonic distortion; employ no moving parts and have same general operating characteristics as maker's standard types; are

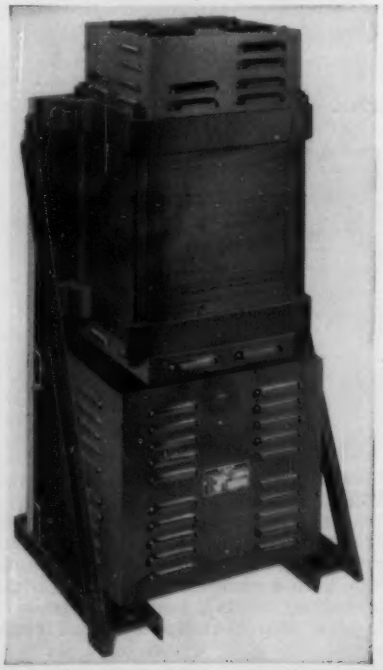


equipped with an additional circuit component which neutralizes the harmonics (normally present in output of constant-voltage transformers). Stabilized output contains less than 3% total harmonic distortion. New transformers thus become particularly useful for general laboratory work, instrument calibration or for use with precision electronic equipment or other equipment having elements which are sensitive to power frequencies harmonically related to the fundamental. They are available in 250-, 500- and 1,000-va. capacities. Identical units may be operated in parallel for higher output capacity.—*Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill.*

Please mention number 417 when filling out card

7½-kva. Constant-voltage Transformer

New 7½-kva. constant-voltage transformer was designed to deliver regulated power to radio and electronic

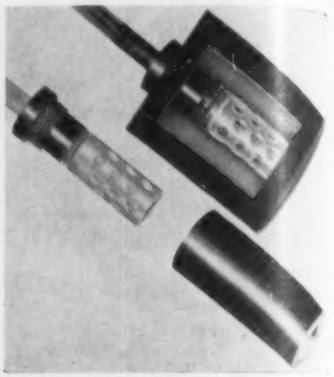


equipment comprising radio aids to navigation and instrument landing systems of airways. — *Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill.*

Please mention number 418 when filling out card

Foundry-mold Moistness Tester

New "Electric Hygro-Cel" is said to measure evaporation of moisture from mold with such accuracy that all guesswork is eliminated, is operated by being

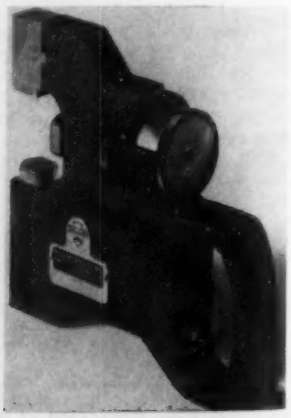


placed in contact with surface of mold. (Tests show that best time to pour, in case of sand-cement molds, is when evaporation from surface of mold drops to approximately zero.) An electric hygrometer sensing element, mounted in a special housing, has a hygroscopic film which changes its electrical resistance instantly with micro-changes in moisture content. Two types of housing are offered, dimensions do not exceed 1¼" × 2¼" × 3". Thirty seconds are required to take a reading.—*The American Instrument Co., Silver Spring, Md.*

Please mention number 419 when filling out card

Dial Snap Gage

New "Nilco Dial Snap Gage" has frame machined from rolled magnesium, with angles at 45° to provide rigidity and minimize dimensional

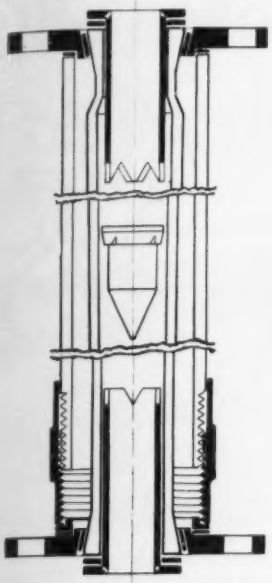


changes caused by temperature fluctuations. Vernier type adjusting stud permits ¼" adjustments to be made in gaging pin or movable anvil. The adjustment can be locked, the gaging pin still remaining free for checking. Construction makes possible the use of a solid upper anvil block, which insures perfect parallelism throughout entire range; also, correct reading as soon as gage is applied without need of "rocking-back-and-forth." New gage is "completely shockproof in every respect and cannot be damaged in the hands of inexperienced operators."—*Nilsson Gage Company, Inc., Poughkeepsie, N. Y.*

Please mention number 420 when filling out card

Chemical-service Rotameter

New "Chemical Service Rotameter" is rigid and self-supporting in a pipeline. Construction avoids expensive end fittings and obviates need for stuffing

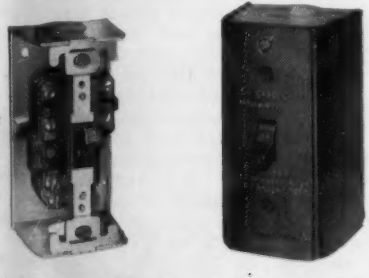


boxes which are expensive to build and maintain. There is no chance of product contamination by stuffing-box packing materials. New design is made possible through use of a recently-developed Corning glass flange on Rotameter tube. In standard models, rotor stop is hard rubber and rotor is stainless steel. On special order, rotor stop may be Pyrex glass or Teflon. An integrally-built Lucite tube (which covers and protects measuring tube) is fitted with a metal adjusting ring permitting it to be held rigidly in position by forcing it against cast iron flanges at each end of Rotameter. At the same time it holds flanges in position for tightening against companion flanges in pipeline. New Rotameter is available in sizes from ¼" to 4".—*Schutte and Koerting Co., 12th and Thompson Sts., Philadelphia 22, Pa.*

Please mention number 421 when filling out card

Instrument-motor Switch

New "Bulletin 600" manually-operated snap switch for starting motors of 1 hp. has an overload device which op-

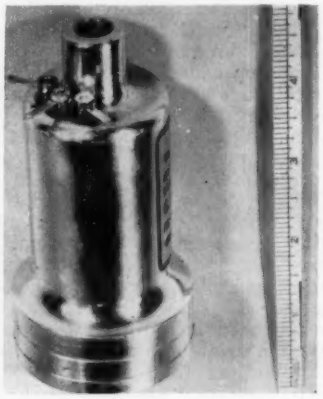


erates on soldered ratchet principle: impossible to hold switch closed under sustained overload, but can be reset easily, with regular switch lever, after overload is cleared. Unit can be furnished without enclosure.—*Allen-Bradley Co., 1326 S. Second St., New York 21, N. Y.*

Please mention number 422 when filling out card

Pressure Pick-up

New "Type 4713 Pressure Transducer," range ±20" water, utilizes slack-diaphragm principle of measurement. One end of a spring-linkage movement is fastened to dome, the other end to a bellows; half of spring is wound

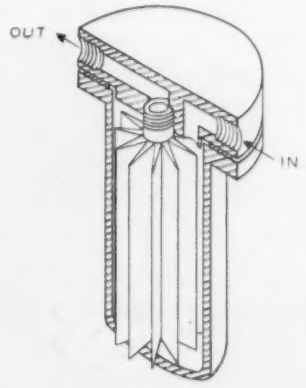


counterclockwise; the other half clockwise. A "Microtorque Potentiometer" wiper is fastened at center of linkage. Resolution is 0.4" water; accuracy 0.4" water, 1% of full range at room temperature; overpressure 3 lbs./in.^{2}; Frequency response 20 cps.; resistance 100 to 10,000 ohms; acceleration to 20*G*'s; temperature exposure from —65°C. to 70°C.; dimensions 3⅞" × 1⅞" diameter; weight less than 6 oz. Output voltages depend upon resistance range. New unit is said to be particularly suited to galvanometer-recorders, strain-gages, telemetering links, etc.—*G. M. Giannini & Co., Inc., 285 West Colorado St., Pasadena 1, Calif.*

Please mention number 423 when filling out card

Filters

New "in-line" filters are provided with interchangeable porous stainless steel elements of various types. Removal of a

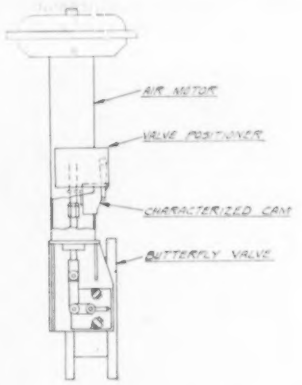


filter element and replacement with another of different porosity or type can be accomplished within a matter of seconds. Bodies are normally supplied for 200-lb. service; higher pressure available. Three principal types of filter elements are provided: cylindrical, bayonet, and star, pipe sizes from ¼" to 1½"; pore openings from 20 to 65 microns.—*Micro Metallic Corporation, 193 Bradford Street, Brooklyn 7, N. Y.*

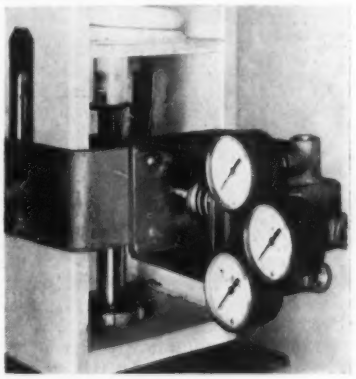
Please mention number 424 when filling out card

D-m. Butterfly Valve With Positioner

New diaphragm-motor valve of disk or butterfly type has a cam-operated positioner whereby control of flow characteristics is attainable by simply



changing cams in the field. In effect, this adds to normal functions of disk type valve. Desirable characteristics of a straight-line, semi-log curve (V-port), ratio plug valve, throttle plug

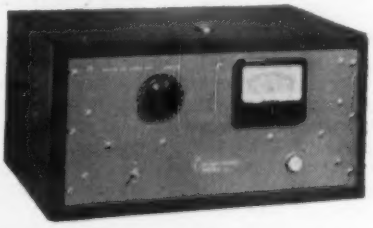


valve, linear, or almost any other special characteristics to suit individual process requirements, are said to be within the range of new positioner.—*R-S Products Corp., 4523 Germantown Ave., Philadelphia 44, Pa.*

Please mention number 425 when filling out card

Regulated High-voltage Supply

New "Model 1090" 0-5000-volt reactance-regulated d-c. supply is arranged for mounting in a standard relay rack. Output varies less than 0.01% with

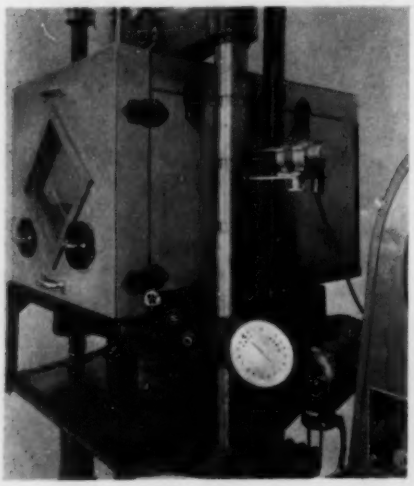


input variation between 90 and 130 volts. Output voltage is continuously variable between 0 and 5000 volts d-c., either positive or negative.—*Instrument Development Labs., 223 W. Erie St., Chicago 10, Illinois.*

Please mention number 426 when filling out card

Temperature-controlled Cabinet for Testing Plastics

New Temperature-controlled Cabinet, for use on maker's testing machines of 60,000- and 120,000-lbs. capacity, for determining physical properties of plastics in tension, compression and flexure over specification range of temperature



of −70°F. to 170°F., is said to incorporate best features of a number of designs developed to meet need of plastics industry. Working chamber, approx. 19″ wide, 18″ high and 20″ deep, accomodates Templin type specimen grips of 5000-lb. capacity, a sub-press for compression testing, flexure tool, standard strain followers for either Templin or Microformer type recorders, and associated equipment. Standard 2″ gage length tension test specimens, compression specimens 2″ × ½″ × ½″, or flexure test specimens up to 16″ × 2″ × 2″ can be tested in chamber, which permits a deformation of 2″ in tension and flexure specimens. Behind working chamber is a servo unit consisting of a dry ice container, a mixing chamber, fan for air circulation, heater coils and electric temperature control equipment. Cabinet is 27″ × 27″ × 40″ over-all, polished stainless steel with 4″ of thermal insulation. Tests can be observed through a double-glazed plate glass window in door, and two handholes with insulated sleeves permit manipulation of apparatus during tests without opening door.—*Baldwin Locomotive Works, Philadelphia 42, Pa.*

Please mention number 427 when filling out card

Vending-machine Type Relay

New "Type 119XBX" midget relay has been specifically produced for electric vending machines and similar equipment requiring small low-cost relays which combine easy mounting and wiring with Underwriters' approval. It has d-p.d-t. contacts rated 5 amperes (⅛ h.p.). Operating coils can be supplied for any a-c. voltage up to 115 volts, 60 cycles. It is approx. 1-3/16″ high × 1⅞″ deep and 1⅜″ wide. All 115-volt relays are adjusted to operate at as low as 85 volts, thus guarding against non-operation of machine under lowered voltage conditions.—*Struthers-Dunn, Inc., 150 N. 13th St., Philadelphia 7, Pa.*

Please mention number 428 when filling out card

Elastic-properties Tester for Fibers, Paper, etc.

New "Pulse Propagation Meter" is an automatic instrument for determining elastic properties of fibers, yarns, fabric, plastics, paper and similar materials by sonic means. Announcement (by Fabric Research Labs., Boston) states that "for the first time, a highly sensitive and quantitative measure of the behavior of materials under various conditions of load, i. e., magnitude of load, duration of load, cyclic loading and unloading, etc., is available." Operating principle: by use of pulse technique (for the first time in this field) the velocity of sound and therefore the elastic modulus are determined in fifty microseconds; instrument then records its findings and repeats its cycle of operation, about two hundred times per second. The smooth curve thus produced is a record of changes in the material being tested as loads are applied, or as a program of elongation is in progress, etc. This pulse technique is applied in the "P.P.M." in such a way as to remove completely any end effects and phase shifts which were sources of error in previous continuous-wave methods. New "P.P.M." contains also its own calibration equipment: a primary crystal-controlled time standard. Textile industry is said to have acquired a new and practical analytic tool." Among other fields: plastics, metallurgy, and "any activity where the time of propagation of a pulse must be determined quickly and accurately."—*Magnetic Amplifier Corp., 4 Gordon St., Waltham, Mass.*

Please mention number 429 when filling out card

Aviation Angle-of-approach Indicator

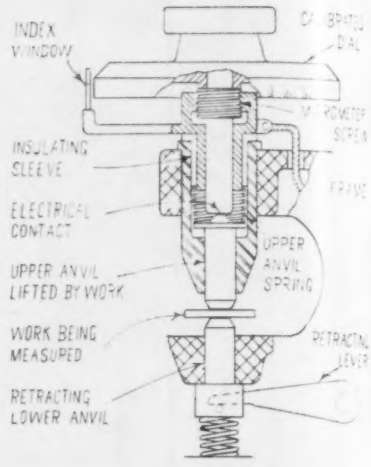
Portable angle-of-approach indicator weighing under 50 lbs. can be moved about the field as desired. A three-colored light beam appears flashing yellow if incoming pilot is too high, flashing red if he is too low, and flashing green if he is at correct altitude. The light beam is flashed 40 times a

minute to distinguish indicator from other steady-burning colored lights. A special lens arrangement keeps a sharp division line—about five feet in a mile —between different colored beams. A circular spirit level permits precise setting. A quadrant arm with level on side of housing provides for accurate setting of approach angle. Sights are provided for aiming. — *Westinghouse Electric Corp., East Pittsburgh, Penna.*

Please mention number 430 when filling out card

Electrical Micrometer

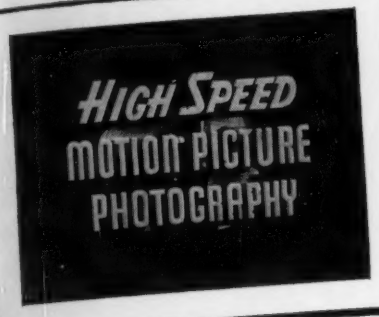
New "Model K Electronic Micrometer," a companion instrument to "Reference Standard Model M" (see *Instruments*, Oct. 1946, pages 633-634)

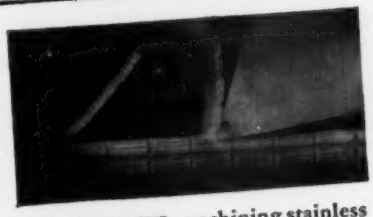


is a lower-cost working standard designed primarily for measuring wire diameter, paper thickness, rubber sheet and paint films and any thin material, hard or soft, conducting or non-conducting. It measures materials as thin as 0.001″ with an accuracy of 20 microinches under work pressures light enough

to cause less than 1% deformation and with readings independent of operator skill or sense of touch. Instrument is equipped with hardened steel anvils of any diameter from 1/64″ to 5/16″, or with any combination of upper and lower anvil diameters within this range. (Spherical faces, and lower anvils up to 2″ diam., also available.) Anvil pressures may be any value from 2 oz. to 1 lb. Standard combination is ⅛″ anvils and 2-oz. anvil pressure, with anvils lapped flat and parallel to 10 microinches. Measuring range of micrometer screw is ⅛″ but micrometer head may be raised if desired to accommodate work up to ⅜″ thick. Micrometer dial is 3″ diam.; each revolution of the dial is 0.025″ as for a hand micrometer. Each 0.001″ is numbered; fine divisions are 0.0001″. Index window is adjustable for setting dial precisely to zero; no special tools are required. Exact dial setting is indicated by lighting of lamp on panel of electronic unit. Repeatability is 10 microinches or better, independent of operator. Unit is supplied with a 6-ft. attachment cord, and operates from any 110-130-volt

FREE Demonstration Film shows how high-speed motion pictures can aid you in research, engineering, and testing

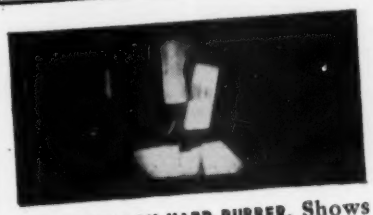




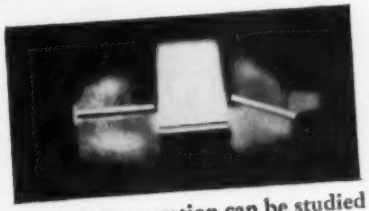
HIGH SPEED CUTTER, machining stainless steel, is photographed with Fastax to find cause of uneven cutting.

VALVE SPRING, while operating at 1500 cycles per minute in truck engine, appears to stand still on the screen.

CIRCUIT BREAKER is examined by Fastax camera to determine detailed behavior of arc.

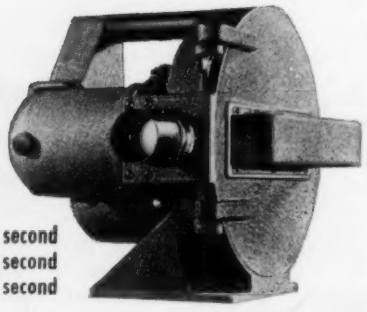


IMPACT TEST ON HARD RUBBER. Shows stress patterns and characteristics of breakage.



PUNCH PRESS operation can be studied at ease by means of Fastax motion pictures.

FASTAX CAMERA



8mm—up to 10,000 frames per second
16mm—up to 5,000 frames per second
35mm—up to 3,500 frames per second

Here's an easy way to see how the Fastax camera has helped others in their research, engineering and testing problems. In this film you'll see super-speed pictures of actual manufacturing and testing operations—plus a detailed demonstration of how the camera operates.

The world's fastest portable motion picture camera, the Fastax is capable of photographing the action of rapidly moving parts—indoors or outdoors, in black and white or color—at speeds up to 10,000 frames per second.

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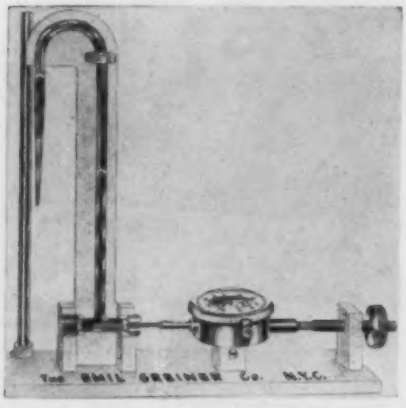
a-c. supply. Operation is unaffected by aging of tubes, vibration, or variations in line voltage, temperature and humidity.—*Carson Micrometer Corp., 2 East Main St., Little Falls, N. J.*

Please mention number 431 when filling out card

Semi-automatic Titration Apparatus

New "Gilmont Ultra-Microburet" is said to permit rapid titration with complete elimination of nerve-racking manipulation; to be capable of a higher



degree of precision; and easier to use than ordinary analytical laboratory buret. A stainless steel plunger displaces mercury in a reservoir sealed off by a silicone rubber gasket contained in an aluminum bushing. Displaced mercury in turn forces a precise amount of titrating solution through fine orifice immersed in solution being analyzed. Plunger diameter being ground to required size, dial micrometer gage reads directly in volume units. Mercury reservoir is made as small as possible so that temperature fluctuations are said to be as negligible as in ordinary macro titrations. Back diffusion into capillary tube is practically eliminated by fine orifice. Stirring of solution may be effected by a fine stream of air bubbles. Constructed entirely of corrosion-resistant materials, "Ultra-Microburet" has a total displacement of 0.1 ml. (in 0.0001 [1/10,000] ml.) with accuracy of 0.03% of total displacement. Microburets for total displacements of 1 ml. (in 1/1,000 ml.) or 0.01 ml. (in 1/100,000 ml.) available upon special order.—*The Emil Greiner Company, 161 Sixth Avenue, New York City.*

Please mention number 432 when filling out card

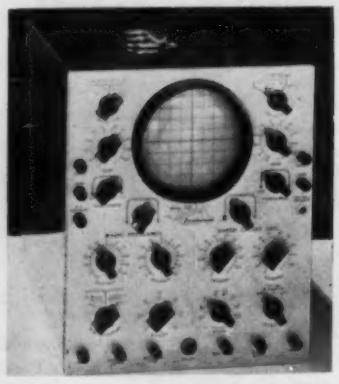
Dummy Antenna Resistors

New "Types D-101" and D-251" dummy antennas replace former glass-enclosed "Types D-100" and D-250" are composed of wire-wound, vitreous-enameled resistors connected in parallel and mounted inside a black wrinkle-finished perforated steel cage. Residual inductance and distributed capacitance have been minimized, making natural resonant frequency as high as possible. D-c. resistance, residual inductance, and distributed capacitance have been proportioned to give best possible response characteristics.—*Ohmite Mfg. Co., 4951 W. Flournoy St., Chicago 44, Ill.*

Please mention number 433 when filling out card

5″ Cathode-ray Oscilloscope

New "Model 505" cathode-ray oscillograph uses new 5UP-1 tube with 5″ screen. Among features: wide- and narrow-band FM oscillator; wide-band high-gain vertical amplifier—to 1 megacycle; modulation circuit permits FM oscillator to be either internally modulated or from an external source such



as phonograph pick-up, or microphones, making FM oscillator into a miniature FM transmitter; self-contained mixer circuit permitting FM output with any good signal generator; demodulator permits any modulated r-f. signal to be viewed; signal tracer jack permits any signal being viewed to be heard by phones; sinusoidal sweep with phasing control for visual analysis of FM and AM receivers; 3-range frequency compensated attenuator network in vertical amplifier.—*Hickok Electrical Instrument Co., 10519 Dupont Avenue, Cleveland 8, Ohio.*

Please mention number 434 when filling out card

Intermodulation System

New system for measurement of distortion caused by intermodulation consists of "RA-1258" signal generator unit and "RA-1257" intermodulation analyzer. In operation, two frequencies are added by signal generator with a minimum of amplitude modulation of one frequency by the other. High frequency is attenuated to a desired ratio (1:1, 1:2, 1:4, or 1:10) and both frequencies combined in a hybrid coil. Output levels range between +23 and −44 dbm at 600 ohms output impedance. Summed voltage is passed through device under test. Output from equipment being tested is fed to analyzer where percentage of intermodulation (or percentage of a-m. of the h-f. signal by l-f. signal) may be closely measured. A distortion phase meter is provided for determining (when measuring variable-density recordings) whether compression is occuring on positive or negative half of l-f. signal. Analyzer functions by first amplifying input signal from device under test, then eliminating l-f. component by means of band pass filters. Resulting h-f. component is amplified and rectified, producing an envelope which is a replica of intermodulation in input signal. Average output of rectifier is attenuated to a reference value, amplified, rectified, and applied to a VTVM adjusted to read percent intermodulation directly.—*Western Electric Co., 195 Broadway, New York 7, N. Y.*

Please mention number 435 when filling out card

Variable Resistor

New "Type RV3-5 Potentiometer" has as standard features: precious metal contacts; two rotor take-off brushes; continuous 360° rotation; precision resistance winding; ganging simplicity; dust-proof construction. Principal new feature is reduction in over-all depth, particularly important in multiple ganged assemblies and when space is a factor. Over-all depth, 1-5/16″. Power rating, 5 watts; nine standard resistance values ranging between 100 ohms and 50,000 ohms. Standard models have an accuracy of ±5% of total resistance (±1% can be supplied).—*Technology Instrument Corp., 1058 Main St., Waltham 54, Mass.*

Please mention number 436 when filling out card

Illuminated Magnifier

New large-lens fluorescent-lighted "Model T-6 Inspector" has a 6½″ lens, said to be the largest used successfully

in an instrument of this kind. It provides a full 6″ dia. of visibility and has a magnification somewhat greater than maker's older 5″ lens models. Lighting is by two 6-watt fluorescent tubes.—*Larrimore Sales Co., P. O. Box 1234, St. Louis 1, Mo.*

Please mention number 437 when filling out card

Self-disconnecting Contactor

New "Failproof Contactor" is a combination contactor, circuit breaker and pilot relay wired with a circuit which trips circuit breaker if contacts of either main contactor of pilot relay stick or weld. It protects instrument-controlled electric heating processes such as furnaces, ovens, etc. Unit con-

It's simple when a recording chart is operated by a Telechron synchronous electric instrument movement. A thermometer or any other recording instrument will write an accurate performance story.

Telechron instrument movements are adaptable to almost any recording device. They're used in the medical field for charting cardiograph and metabolism tests . . . in industry for temperature and flow charts and a wide variety of industrial processes. They actuate either lineal or circular charts. Their perfect synchronism allows direct comparison of any number of instruments. Terminal shaft speeds range from one revolution in five minutes to one in 30 days.

Accuracy and dependability are assured by the Telechron motor used to drive these instrument movements. This is the motor that is used so widely to power general-purpose time switches, cycling timers, automatic controls, and other industrial timing and recording devices. It's precision-built and lubricated by Telechron's exclusive oiling system to give long service and keep maintenance costs low.

Telechron motors are made by the largest producer of synchronous electric motors and timing devices for over 25 years. And every one is Underwriters Laboratories approved. Telechron application engineers are always glad to discuss your timing and control needs. Write Motor Advisory Service, Dept. B, Telechron Inc., Ashland, Mass.

See our CATALOG in SWEET'S FILE for PRODUCT DESIGNERS

Telechron motors are now being used for:

- Stoker, Oil Burner and Temperature Controls
- Industrial Process and Cycling Timers
- Business Machinery
- Medical Devices
- Household Appliance Timers
- Musical Devices

THE FIRST AND FAVORITE SYNCHRONOUS ELECTRIC TIMING MOTOR

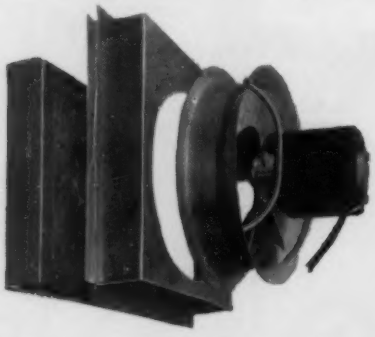
Telechron
REG U S PAT OFF
SYNCHRONOUS MOTORS

sists of a standard contactor, a "Failproof Circuit Breaker" and a "Failproof Pilot Relay" mounted and wired in an enclosing cabinet. "Failproof Pilot Relay" acts as a thermostatic relay for 3-wire instrument control. "Failproof Circuit Breaker" trips at any desired overcurrent, eliminating necessity for line disconnect switches and fuses. "Failproof Control Panels" are available in two and three poles up to 550 amp. and 600 volts.—*Packard Utilities Mfg., Inc., 111 Edgewood Avenue, New Haven 11, Conn.*

Please mention number 438 when filling out card

Instrument-cabinet Exhaust Fan

New propeller type fan is expressly designed for flushing instrument cabinets. It is designed for both "push" and "pull" operation; is obtainable

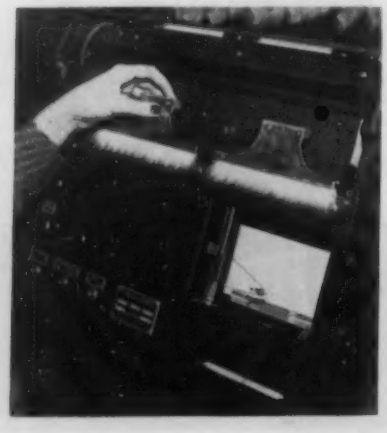


with a variety of propellers to suit different conditions of back pressure; can be mounted directly on a 10″ × 10″ dust filter, allowing cabinet to be flushed with clean air and keeping it under a slight over-pressure. Motor is totally enclosed, has two accurately aligned "precision" type ball bearings with felt seals, and can be operated with its shaft in any position. Unit is finished for operation under adverse climatic conditions.—*Rotron Division, 180 Weeden St., Pawtucket, R. I.*

Please mention number 439 when filling out card

Automatic Statistical Analyzer for Cotton Fibers

New "Fibrograph" employs phototubes for scanning samples of parallel cotton fibers and simultaneously traces a length-frequency curve whose geometrical properties make it possible to readily and quickly determine various average length intervals, variance and coefficient of variation. Comparative



accuracy tests at Univ. of Tennessee: Three cottons were carefully sampled and more than 3,000 fibers from each measured by laborious projection method and by using "Fibrograph." Results were that "Fibrograph" length multiplied (on average) by 1.19, gives absolute length of fibers. Another test was comparison of measurements on ten varieties obtained by "Fibrograph" and determined by an expert classer; individual means and grand means were even closer. "Fibrograph" operates on 110-120-volt, 60-cycle a.c. (extra cost for other operating currents); dimensions 12″ × 14″ × 21″; fibrogram card size, 3″ × 5″; accessories supplied, 4 fiber combs, 1 fibroscale, 1 bottle ink, 100 fibrogram cards, 1 fiber brush, one 8-foot extension cord; shipping weight, 80 lbs.—*Dept. FP, Fulton Sylphon Div, Robertshaw-Fulton Controls Co., Knoxville, Tenn.*

Please mention number 440 when filling out card

Instrument-shop Impact Wrench

New "Size No. 18-6" Impact Wrench has a nominal capacity of ⅝″ bolts. Design is similar to that of ⅜″ "No.

18-4." By means of a built-in torque regulator, power is adjusted to requirements of job. Length, 8⅞″ over-all; net weight, 9 lbs.—*Keller Tool Co., Grand Haven, Mich.*

Please mention number 441 when filling out card

High-gain Amplifier for Instrumentation Uses

New very-high-gain single-frequency amplifier, for use in servomechanism circuits, laboratory experimentation, etc., is suited for work in conjunction with thermocouples, bolometers, strain-gage bridges and other bridges. Parallel-T filters are of plug-in type. Frequencies from 4 to 45 cycles with bandwidths from 1 to 5 cycles wide are available. Maximum gain is 5×10^7 with an input noise level less than 10^{-9} volts. Design makes special selection of tubes unnecessary. Low input impedance (10 to 50 ohms) permits matching to low-impedance bridges. Output of amplifier may be had as an average rectified d-c. signal suitable to drive a standard 0-1 milliampere recording galvanometer or as a.c. with a maximum undistorted output of 30 volts. Circuit consists of a high-gain input transformer, four stages of amplification, a rectifier, and a cathode follower output tube. A filter (to eliminate power frequency) may be removed from circuit; another filter is used as an inverse feedback loop over one stage to give a narrow bandpass. This filter may also be removed to give a broad-band response with a gain of 1.5×10^8. Amplifier section, separate from power supply, is mounted to eliminate vibration pick-up. Power supply operates on 115 volts a.c. Dimensions of each section, 7″ × 17″ × 12″.—*The W. S. Macdonald Co., 33 University Road, Cambridge 38, Mass.*

Please mention number 442 when filling out card

Combustion Safeguard

New model of "Flame-otrol" combustion safeguard for gas- and oil-fired furnaces, etc., embodies two new improvements: A "Safe Start Relay"

mounted on chassis prevents operation in event that any unsafe condition exists during start-up period. Even depressing push-button of manual reset will not put system in operation until a safe condition is assured. "Flame-eye" sensing unit for oil-fired equipment is now equipped with a blue-sensitive phototube responsive only to rays characteristic of oil flames, eliminates detrimental effects of red rays reflected from furnace walls or other extraneous sources.—*Wheelco Instruments Co., 815 W. Harrison St., Chicago 7, Ill.*

Please mention number 443 when filling out card

Precision Switch

New "Type SA-1" d-p.d-t. snap-action precision switch comprises two standard maker's switches, ganged for mount-

ing on usual 1″ centers, is equipped with a duplex "Adaptaplate" which actuates both switching elements simultaneously on application or release of operating force. Body dimensions 1 15/16″

HERE'S NEWS!

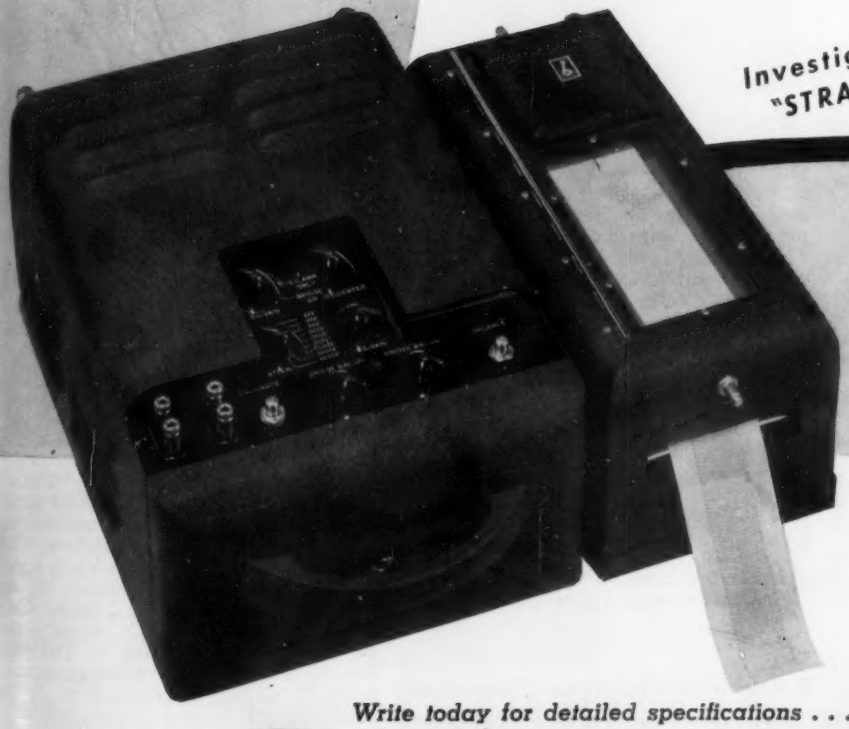
If you want IMMEDIATE records of strains...

● Here's a strain measuring device that produces records immediately for interpretation. The "STRAIN ANALYZER" consists of a Model BL-310 Strain Amplifier and the Brush Direct-Inking Oscillograph. It's completely self-contained, requiring only two external strain gage connections, one dummy gage and one active gage cemented to the piece being tested.

The equipment records either static or dynamic strains up to 100 cps. Direction as well as magnitude of the measured strains can be read from the record. The "STRAIN ANALYZER" is readily calibrated for individual gages so that the strain can be read from the chart directly in microinches per inch.

When used with Baldwin Southwark SR-4 Gages of 120 ohm resistance, the maximum sensitivity of the unit is 10 microinches per inch strain per chart division pen deflection. An attenuator switch changes the sensitivity in the following steps: 10, 20, 50, 100, 200, 500, 1000 and 2000 microinches per inch per division. While specifically designed for the 120 ohm gage, the equipment can be used for higher resistance gages. It is also applicable for use with many resistance sensitive pickups and can be used to record pressures, temperatures, accelerations, forces, etc., provided the equipment is calibrated in the terms of the particular pickup used.

Investigate the "STRAIN ANALYZER"



The new Model BL-310 Strain Measuring Equipment with Brush Direct Inking Oscillograph.

Write today for detailed specifications . . .

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long, 1⅜" wide, and 15/16" high including "Adaptaplate;" over-all length including "Adaptaplate," 2⅛". Ratings of 15 amperes at 125 volts and 5 amperes at 250 volts a-c.—*Unimax Switch Corp., 460 W. 34th St., New York 1, N. Y.*

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Dual Concentric Shaft Control

New dual concentric volume and tone control measures 57/64" in diameter, was designed for television and auto radio markets, but is for instruments in which it is desirable to centralize two independent functions for handy control on instrument panel. It is available (1) as a dual unit with single control at the panel, (2) as a dual concentric with two separately-controlled continuously-variable resistance units mounted in tandem, or (3) as a dual concentric with one continuously-variable unit, and one tone switch in tandem. Standard "on off" switches are available with all types, if required. — *Stackpole Carbon Co., St. Marys, Pa.*

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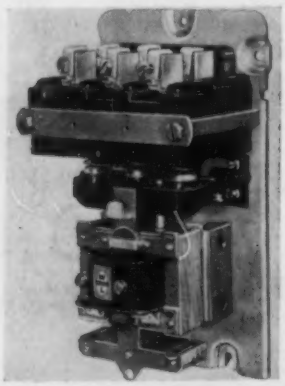
Solenoid Contactors

New "Size 2 Bulletin 4452" and "Size 3 Bulletin 4453" a-c. solenoid contactors are intended primarily for use in a-c. motor controllers, are also suitable



for application in resistive heating controls, lighting controls, etc., for remote and automatic load switching purposes. Features include: complete accessibility of parts, built-in solderless connectors, massive double-break silver contacts. Size 2 and 3 units have maximum ratings of 25 and 50 h.p. respectively, 440-550-volt 3-phase 60-cycle. Standard operating coils for 110-, 220-, 440- and 550-volt operation on 25, 50 or 60 cy. Additional auxiliary contacts for control circuit purposes are obtainable.—*Ward Leonard Electric Co., Mount Vernon, N. Y.*

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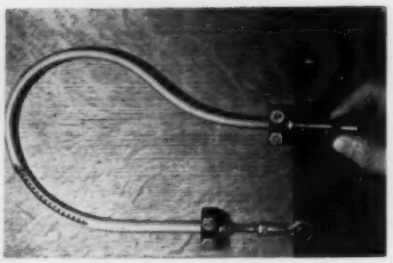
Push-pull Controls

New line of push-pull controls provides manual remote control of mechanical, hydraulic or other devices,. Three types are available: (1) Light duty—⅜" O.D. rigid housing, load range to 1250 lbs. ultimate compression; (2) heavy duty—7/16" O.D. rigid housing, has load range to 1650 lbs. ultimate compression, and (3) Extra-heavy



duty—½" O.D. rigid housing, has load range to 3050 lbs. ultimate compression. Moving element is made up with flexible tinned aircraft cable over which a series of steel or stainless steel spherical shells are strung, as shown in cutaway portion of illustration of light duty controls. — *Southwest Products Co., 10 So. Catalina St., Pasadena 1, Calif.*

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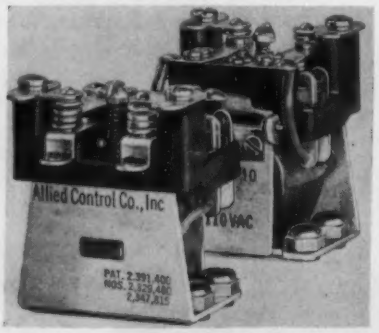
All-purpose Electronic Control Relays

New "Type PO" and "Type POY" relays replace earlier "DO" and "DOY," have been entirely redesigned to save space and cost and deliver



extra-long service. "Type PO" is supplied in 2-, 3- and 4-pole normally closed, normally-open or double-throw contacts; silver contact capacity 15 amperes at 24 volts d.c. or 110 volts a.c. non-inductive; coil rating up to 220 volts, 25 and 60 cycles at 10.5 volt amperes; 120 volts d.c. at 2.5 watts; dimensions of 3-pole: height 2¼", length 1⅞", width 1⅝"; 4-pole is 2¼" × 1⅞" × 2-3/16". "Type POY," intended for operation direct from plate of a vacuum tube or other limited power circuit, is a semi-sensitive, dual-coil relay for d.c. only; identical with "Type PO" in contact arrangements, ratings and dimensions; coil rating up to 110 volts d.c. at 1 watt. Both "PO" and "POY" may be obtained hermetically sealed.—*Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y.*

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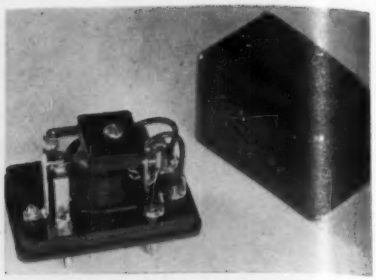
Relay with Plug-type Connectors

New design of maker's relay is especially adapted for machine tools, etc., which require fast servicing when shut down because of relay failure. Plug type connectors, merely inserted into receptacles mounted on machine panel, make replacement time a matter of seconds. No risk of wrong connections



when replacing. When desired, rear terminals can be furnished in place of the plug connectors. Removable molded phenolic cover tightly joins the molded phenolic mounting base, completely enclosing relay and leaving only the plug connectors protruding. (This cover is optional.) Simplification of working parts and reduction of their number has added greatly to relay's life and efficiency. Available in various contact arrangements, relay ranges from 6 to 230 volts, a.c. or d.c. Silver contacts are rated at 10 amperes per pole on a resistive load. Length, 3¼"; width, 2-5/16"; height including plugs, 2-9/16"; height not including plugs, from mounting surface to top of cover, 2".—*Dep't I, Grayhill, 1 North Pulaski Road, Chicago 24, Ill.*

Please mention number 449 when filling out card

High-speed D-c. Relay

New model of "Millisec Relay" has operating time as short as 1/3 milliseconds and is assembled in hermeti-

cally-sealed metal container with 8-prong octal base to fit standard socket. It is made in two sizes, s-p.d-t. and d-p.d-t. for use with resistive loads. When used with inductive loads special tests are required at factory in conjunction with actual load. Only d.c. is used on the contacts. A.c. is not recommended. Contract rating is 110 volts, d.c., ½ ampere. Life expectancy varies from 22 million operations at ½ ampere to 100 million operations at ¼ ampere. Coils are wound for d.c. only. Either 38 volts, 3100 ohms or 24 volts, 1600 ohms d-p.d-t. or 18 volts, 1400 ohms, or 6 volts, 150 ohms s-p.d-t.—*Stevens-Arnold Inc., 22 Elkins St., South Boston, Mass.*

Please mention number 450 when filling out card

The battle of the atoms

Telephone equipment is constantly at war against invisible forces of nature which seek to take it apart, atom by atom. On all fronts, Bell Laboratories chemists must fight corrosion — an enemy able to make a telephone circuit noisy or perhaps to sever it altogether.

An example: for years lead cable had lain protected in wooden ducts. Then in certain areas something began to eat the sheath, exposing wires to moisture. Corrosion chemists of the Laboratories were called in. The corrosion, they found, came from acetic acid generated in the wood during the preservative treatment then in use. They pumped in neutralizing ammonia. Corrosion stopped. Now telephone duct wood is controlled for acidity.

In a large city, smoke-polluted air was coating the silver surfaces of contacts with sulphide. Noisy circuits resulted. Chemists discovered minute traces of sulphur vapor in the air. They filtered incoming air with activated charcoal. Today, the latest telephone contacts are of palladium — not affected by sulphur.

Corrosion in metals is only one type of deterioration which engages Bell chemists against hostile forces. Plastics, paper, metals, rubber, textiles, coils, waxes and woods all have enemies. But knowledge, and persistence, are steadily winning out—to the benefit of the telephone user.

A Bell Laboratories corrosion engineer examining samples during an exposure test on corrosion-resistant finishes and alloys.

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE

Simultaneous Measurement *of* Tensional *and* Electrical Resistance *of* Fine Wires

By J. T. NORTON, Massachusetts Institute of Technology, Cambridge, Mass. and
G. C. KUCZYNSKI, Sylvania Electric Products Inc., Bayside, L. I., N. Y.

SIMULTANEOUS determination of stress, strain and electrical resistance of fine wires (less than 0.002″ diameter) is important for testing wires (materials) subsequently used in the development of electrical resistance strain gages. A modification of an ordinary analytical balance as shown in Fig. 1 was found useful in such measurements. It consists of a light well-balanced beam BB, on the two ends of which a load W and hanger H are suspended. A brass tube D, hollow at one end, is attached to hanger H. The hollow part is filled with suitable solder. One end of the wire under test is soldered to this tube. The other end is soldered to a brass cylinder C, whose position may be changed vertically. Proper adjustment of screws K brings the needle N to the zero position at the beginning of measurements. The cylinder C is directly connected to the d-c. Wheatstone bridge with a heavy copper wire. The other contact is made through two platinum electrodes ZZ immersed in a mercury cup M. This contact is reliable if the mercury is clean. A heavy brass frame A bolted to a thick Bakelite plate EE supports this structure and is immersed in a constant-temperature kerosene bath J. A photograph of the instrument is given in Fig. 2.

The increments of stress applied to the wire are readily obtained from increments of weight placed on the loading end of the beam BB (Fig. 1) and the cross-section area of the wire. The increments of the length of the tested wire are measured with a cathetometer, which allows an accuracy of about ± 0.005 mm., or suitable dial gage. In order to eliminate the error arising from the refraction of light in the wall of cylindrical container J, part of the wall is replaced by an optically flat piece of glass (see Fig. 2). The reference marks are made on brass tube D. This does not cause any appreciable error as the maximum stress in this tube never exceeds 1.5 kg./cm.^{2}. Electrical resistance is measured with the d-c. Wheatstone bridge. The low resistance of the metallic wire specimen requires a careful determination of the resistance of the connecting leads. Any possible error due to thermoelectric effects at the solder-metal contacts is eliminated by using the reversing switch.

Mention should be made of the soldering technique. In general the ends of the wire to be soldered are wrapped in a small piece of solder sheet and then immersed into molten solder in the brass tube D and C (Fig. 1). Ordinary lead solder can be used for such metals as copper, nickel, cobalt, iron and their alloys. For low-melting-point metals such as tin, bismuth, lead and their alloys, Wood's metal is excellent. For aluminum and its alloys "Alumaweld Solder" and flux developed by Lloyd S. Johnson Co. can be used; unfortunately, some components of this solder, probably zinc antimony, form brittle compounds with aluminum which renders it unusable for thin aluminum wire (0.001″ diameter).

Wires of such metals as tungsten, molybdenum and tantalum, which cannot be soldered directly, are first spot-welded to pieces of thick nickel wire and the nickel wire soldered into the brass tubes.

The limiting factor in the accuracy of stress measurement is the determination of diameter of wires (about 0.00005″). The errors due to the deviation of the beam from the horizontal and buoyancy of the platinum electrode in the mercury are negligible ($<0.5\%$).

The apparatus described above was built in the Metallurgy Department in M.I.T. and used for determination of gage factors and fatigue characteristics of fine metallic wires.

Acknowledgment: This work was supported by the fellowship granted by Baldwin Locomotive Company in Philadelphia. The authors are indebted to Mr. R. Carl for skillful construction of the apparatus.

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(1) A. V. de Forest, "Wire Resistance Strain Gages," *Instruments*, Vol. 15, April 1942, pages 112-114, 136, 137.

(2) The Baldwin Locomotive Works, Baldwin Southwark Division, Philadelphia, *SR-4 News letter*, No. II and III, October and November 1944.

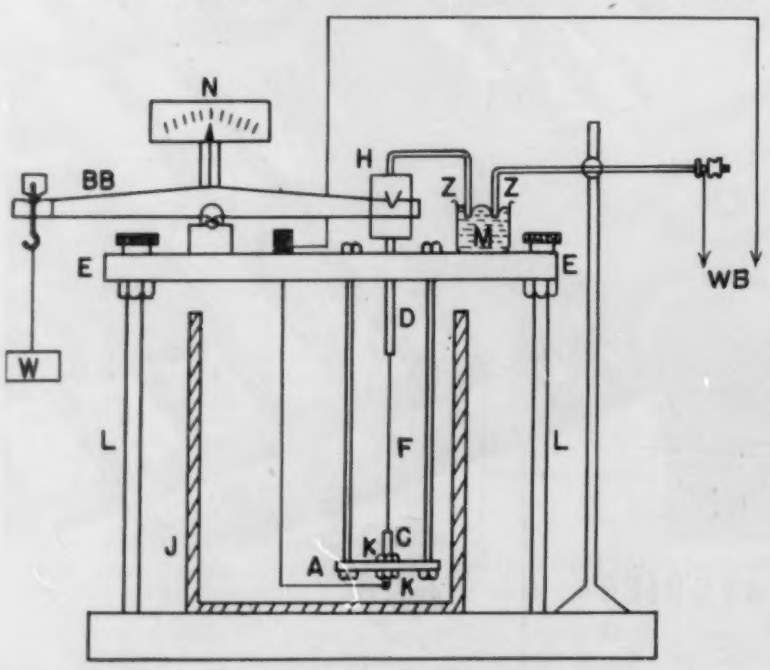

Fig. 1. Apparatus for measurement of gage factor and tensile properties of fine wires.

BB—Balance beam
W—Weight
N—Scale
H—Hanger
F—Wire being tested
J—Jar with kerosene
EE—Bakelite plate
KK—Adjusting screws
M—Mercury contact
C—Brass cylinder
ZZ—Platinum electrodes
WB—Wheatstone bridge

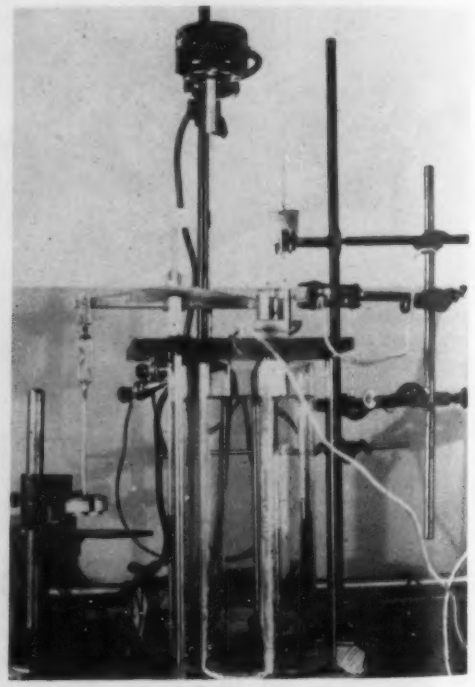

Fig. 2. Constant-temperature bath and apparatus for stressing the wire.

A Fifty-point Bridge Balance Unit *for* Use *with a* Baldwin SR-4 Strain Indicator

By N. C. FICK and N. A. CRITES, Research Engineers, Battelle Memorial Institute, Columbus, Ohio.

Introduction

WIRE strain gages for direct measurement of stresses can be attached to complicated shapes which are nearly impossible to analyze mathematically. In order to run a complete experimental analysis of a large structure, many gages may be required. The ordinary strain indicator is not equipped to handle a large number of gages in rapid sequence, because of the necessity of disconnecting and reconnecting gage wires. A supplementary switch box is necessary. However, the switch box alone does not provide a means of balancing these gages so that they will always fall within the working range of the strain indicator. Even though it is possible to get a large number of gages to balance somewhere in the working range of the instrument, a separate balance will have to be obtained for each gage. Thus, with each gage balanced in a different position, the strain for each gage will have to be calculated independently. This involves time-consuming arithmetical computations that can be eliminated by means of the instrument herein described. In this instrument, the switch is combined with the balancing unit so that final readings are directly obtained in micro-inches.

The authors had the problem of reading fifty strain gages consecutively in the course of a complete stress analysis of a structure under progressive loading. There was needed an instrument of the null-point type, which would both switch and balance each gage individually in conjunction with the single-gage type Baldwin SR-4 Strain Indicator. Therefore, the device described in this article was designed and built at Battelle.

Problems Involved

Two basic problems were involved. One was to obtain a multiple-point switch which would have a constant contact resistance. The other was the problem of devising a satisfactory method for obtaining an extremely sensitive variable resistance that could be used for balancing the strain gages.

Construction

The multiple-point switch problem was solved by purchasing six 5-gang 11-point switches and using one of the switches for parts to add an extra deck to each of the other five switches. When finished, each switching unit consisted of two three-deck switches coupled to the same shaft. The six decks were divided into two groups. Each group of three decks was wired together to function as a single 11-point switch. This was done to insure uniform contact resistance. One unit of the switch was wired to the balancing resistances; the other unit was wired to the measuring gages.

Several avenues of approach were open for constructing the gage-balancing device. It would be possible to use a slide-wire resistance. The commercially-available slidewire rheostats, however, were too bulky for our use.

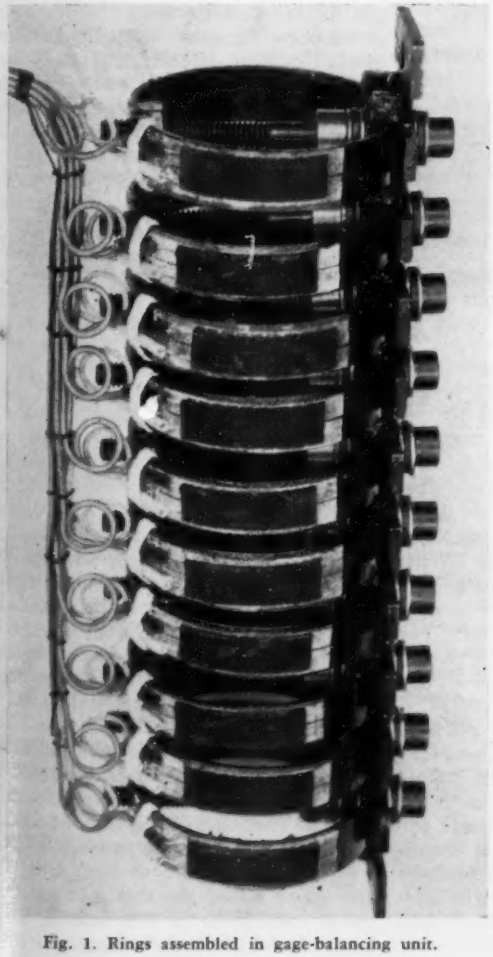

Fig. 1. Rings assembled in gage-balancing unit.

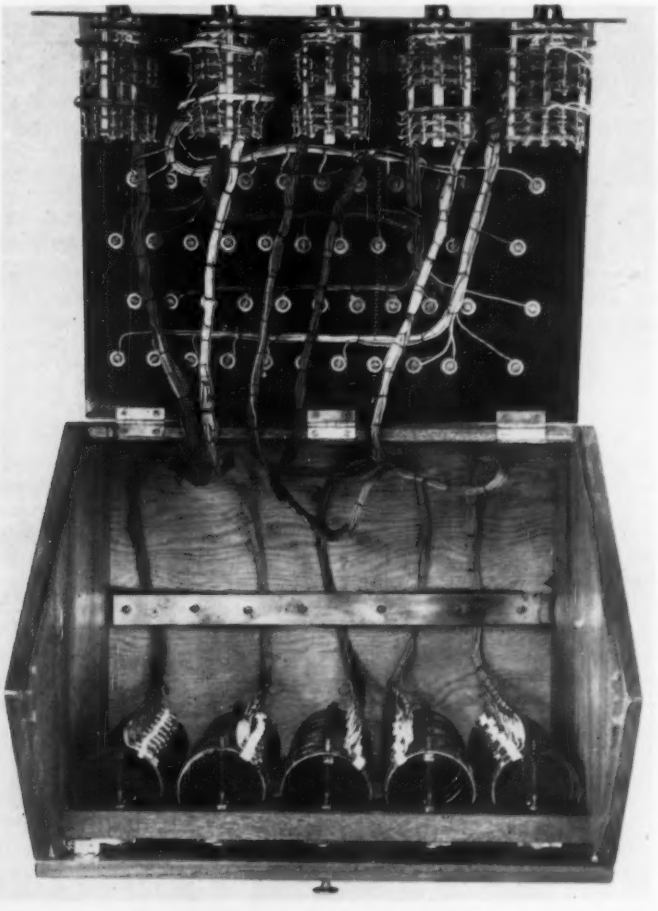

Fig. 2. Top view of cabinet opened to show wiring and arrangement of switches and balancing rings.

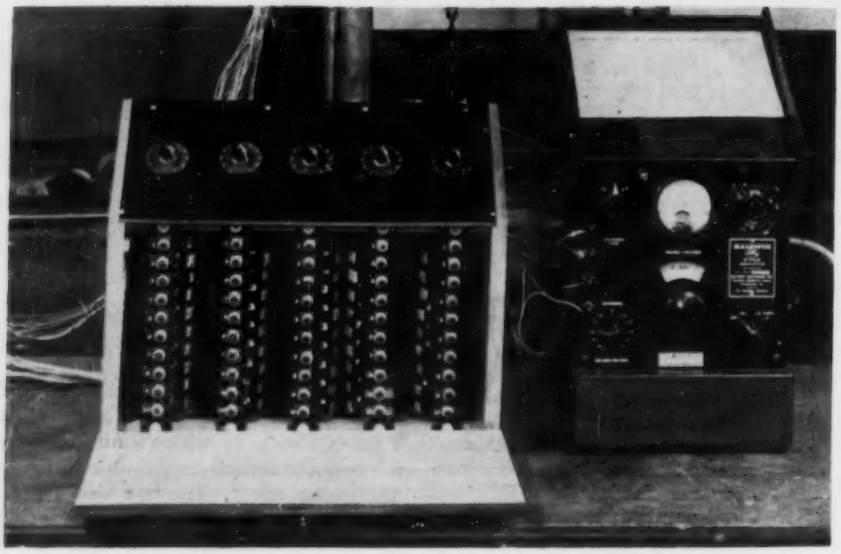

Fig. 3. The combination switch box and gage-balancing unit with Baldwin SR-4 Strain Indicator in position for use.

Another possible method was to attach compensating gages on cantilever beams. If the beams are all attached to one plate, it becomes difficult to adjust one beam without affecting the others; therefore, this method was discarded.

It was found desirable to go to a geometric shape such as a ring that could be deformed without applying any stress to the supporting structure. This was accomplished by drilling two diametrically-opposed holes in the rings and inserting heat-treated cap screws, which were threaded through nuts silver-soldered to the rings. These rings were 2½" in diameter and ½" wide. They were cut from low-carbon 1/16"-gage seamless steel tubing. In order to impart the desired spring qualities, the rings were carburized and heat treated. These rings were assembled in sets of ten as shown in Fig. 1. By building up banks of these ten-ring units for each 11-point switch, the capacity of the balancing unit can be extended to meet any requirements. If more than one switch is connected in series, it is necessary to use one point to keep the circuit open. That is, if five banks are connected in series, four of the banks will be turned to the open position.

Fig. 2 is a top view of the bridge balancer, showing the wiring and arrangement of switches and balancing rings in the cabinet. The binding posts with which connections to the measuring gages are made are located on the back of the Bakelite panel shown in Fig. 2. Each 10-ring circuit is separate and the common wire from each of these circuits also leads to a binding post on the panel.

Operation

Fifty SR-4 strain gages were attached to the structure at the various positions of interest. These were wired in the conventional manner. The common wires were attached to the common binding posts on the panel. If there is only one common wire for the whole system, then all five of the binding posts must be connected in series. Each switch is turned to the open position except for the bank in use. The next operation is to balance each individual gage. The first step consists in zeroing the microinch dial of the strain meter. The arrangement of the strain meter in the system is shown in Fig. 3. Approximate balance is then made by means of the reference taps on the strain meter. The final balance is made by adjusting the rings which have the compensating gages attached. With each of the gages balanced, it is now possible to record all stress readings directly in microinches. Where a number of gages are concerned, this will save many hours of time.

If negative stresses are expected during the loading of the structure, it will be desirable to balance the reference taps in one of the middle positions, so that final readings can be obtained on either side of zero.

Conclusions

This apparatus is simple in design and construction; relatively foolproof; quite satisfactory in actual operation. Since the gages are pasted on steel, the device also furnishes temperature corrections for measurements made on steel. However, if the balancer is used to obtain strain measurements on other materials such as aluminum, magnesium, copper, etc., it will be desirable to see that measurements are made at constant temperature.

Authors' Footnote: A simple device somewhat similar in function to the one herein described has recently appeared on the market. Elaborate fully-automatic gage-balancing and recording strain-measuring instruments have been commercially available for a number of years.

Simplified Dynamic Strain Equipment

By WILL J. WORLEY, University of Illinois, Urbana, Illinois

DYNAMIC strain measurements ordinarily require expensive equipment often not easily obtained. A method of adapting a commercial unit (the Baldwin-Southwark Portable Strain Indicator) to repeated dynamic strain measurements is here reported.

The measurement of repeated dynamic strains (often referred to as repeated loads) using SR-4 electric-resistance wire-type strain gages requires a number of circuit components. Ordinarily, a Wheatstone type bridge circuit (containing SR-4 gages as two of its branches) is fed by an audiofrequency oscillator. The bridge output is coupled to an amplifier by means of a coupling transformer. The amplifier output is then coupled to an oscilloscope through a suitable filter. With proper shielding the filter may be eliminated.

The Strain Indicator contains the necessary circuit elements for repeated dynamic strain measurements, with the exception of an oscilloscope. This instrument contains an oscillator which supplies a 1000-cycle carrier frequency to a bridge circuit, two elements of which are SR-4 strain gages. A coupling transformer is used to couple the bridge output to a three-stage amplifier. The amplifier output is coupled, by means of a transformer, to a phase-discriminating rectifier and a null balance indicating instrument.

Since dynamic measurements may be made using an oscilloscope as the null balance element in the circuit, the phase-discriminating rectifier and the indicating instrument in the Strain Indicator need not be used. The method of adapting the Strain Indicator to dynamic measurements consists of the following procedure.

In order to disconnect the indicating instrument from the bridge circuit the rectifier element is removed from its socket. The output of the three-stage amplifier is then tapped at a point which will give the desired amplification. For all of the dynamic measurements which have been made, it has been found that the signal from the

plate of the second stage of amplification gives desirable results when tapped off through a 500-mmfd capacitor. The capacitor is used to couple the amplifier output to a cathode-ray oscilloscope. The circuit is completed by grounding the case of the Strain Indicator to the oscilloscope ground. A block diagram of the circuit is shown in Fig. 1. The active gage, A, and the temperature-compensating gage, C, are shown.

The removal of the rectifier mentioned above is found to be desirable for the following reasons. As soon as a dynamic strain is imposed on the active strain gage, the pointer on the null

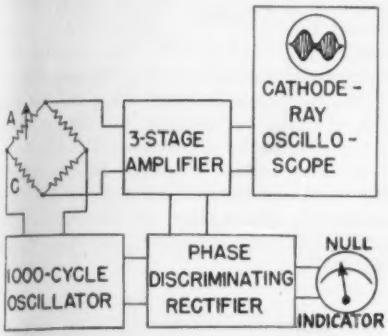

Fig. 1

balance indicating instrument will oscillate and this might result in mechanical damage to the indicating instrument. The desired effect could have been obtained by disconnecting the indicating instrument but the suggested procedure permits the indicating instrument to be left in the circuit for checking the battery voltages. It is apparent that a switch could be provided to disconnect the rectifier from the circuit and thus avoid the necessity of removing the rectifier from its socket to adapt the Portable Strain Indicator to dynamic measurements.

In order to introduce the procedure which may be used to obtain dynamic strain measurements, it may be well to define the problem which was to be solved when this adaptation was developed. The problem was to determine the dynamic magnification factor which was produced in a Krouse bending fatigue machine, in order to correlate the static readings with the dynamic readings and hence obtain a calibration of the machine.

The actual procedure used in conducting a dynamic calibration involves the following technique when applied to a constant-amplitude-of-deflection type Krouse fatigue testing machine. A specimen is mounted in the machine with an SR-4 strain gage attached near the critical section (the gage is not placed directly over the critical section because the gage tends to fail in fatigue if placed at that point). The active gage and the temperature-compensating gage are then connected to the SR-4 indicator in exactly the same manner as for static measurements. The output lead from the 500-mmfd capacitor is then connected to the vertical input on the oscilloscope. The ground on the SR-4 Indicator is then connected to the oscilloscope ground. This completes the circuit.

When the switch on the Strain Indicator is turned on and the oscilloscope is set on a suitable sweep frequency, a pattern or line appears on the oscilloscope screen. In order to obtain a measurement, the specimen is given the desired static deflection and the pattern on the oscilloscope screen is adjusted to minimum amplitude by balancing the Strain Indicator as for static tests. The only difference between the regular procedure for static measurements and the procedure being considered is that the null balance is affected by means of an indicating instrument for one and by means of an oscilloscope pattern for the other.

The specimen is then deflected in the other direction (assuming a reversed cycle of stress is being studied), and the above balancing procedure is repeated. The fatigue machine is then turned on and a modulated dynamic wave form appears on the cathode-ray screen. The modulated wave will be found to move across the screen and the sweep frequency synchronization must be adjusted to stop or nearly stop the transverse motion of the wave envelope. If manual control is undesirable, external synchronization may be used to make the pattern stationary. Bridge balance for the dynamic condition is then obtained by adjusting the instrument until 100% modulation is achieved. Two settings of the balancing elements on the SR-4 Indicator will be found to give 100% modulation for the dynamic readings; one dynamic reading will correspond to the first static reading and the other dynamic reading will correspond to the second static reading. The ratio of the difference between the maximum and minimum dynamic readings to the difference between the maximum and minimum static readings gives the magnification factor.

If the bridge circuit in the Baldwin Southwark Indicator (which includes the compensating gage and the active gage) were perfectly balanced and the exciting oscillator supplied a perfect wave-form, an undistorted sine wave should result. Actually this is not the type of wave-form which appears on the screen, since a slight unbalance in the bridge circuit results from capacitance of the leads to the SR-4 gages and other reactive unbalance in the circuit as well as a possible distortion in the oscillator wave. The wave-form which usually results has the general form of a sine wave but with a small-amplitude wave having two or three times the modulated wave frequency superimposed upon it. The smaller-amplitude wave usually is not symmetrical but for ease in balancing it may be desirable to make it symmetrical and this may usually be done by either adding or removing a slight amount of capacitance across either the active or the compensating gage terminals of the Indicator, depending on the sense of the unbalance. Occasionally enough change in capacitance can be effected by changing the spacing between the strain gage leads over a portion of their total length. The superimposed wave has a desirable effect in some instances in obtaining a null balance since it results in a composite wave-form having a flat top. Balance is assumed to exist when the two ends of the flat top are at the same height.

The oscillograms in Fig. 2 were taken for three typical oscilloscope patterns. The pattern in Fig. 2A shows the condition of static balance for an SR-4

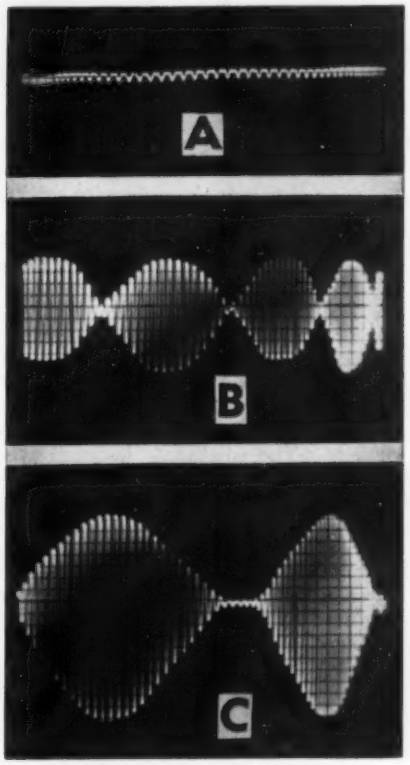

Fig. 2

strain gage mounted on a specimen in a Krouse bending fatigue machine. As stated above, it will be noted that the wave-form has a flat top which was produced by a fixed capacitance placed across the compensating gage terminals, in addition to the effects produced by the capacitance unbalance of the strain gage leads. It was found that the pattern could be brought back to the same static balance with greater ease if the flat-top wave were present. It will also be observed that there is a slight wave-form pattern from one end of the complete pattern to the other. This wave was caused by 60-cycle pick-up and is not always present. When it is present it does not create any problem since the amplitude is small. The wave-form in Fig. 2B represents a condition of dynamic operation with an intermediate bridge slidewire position between the maximum and minimum dynamic balance. The pattern in Fig. 2C represents a condition of maximum dynamic balance. The wave pattern for

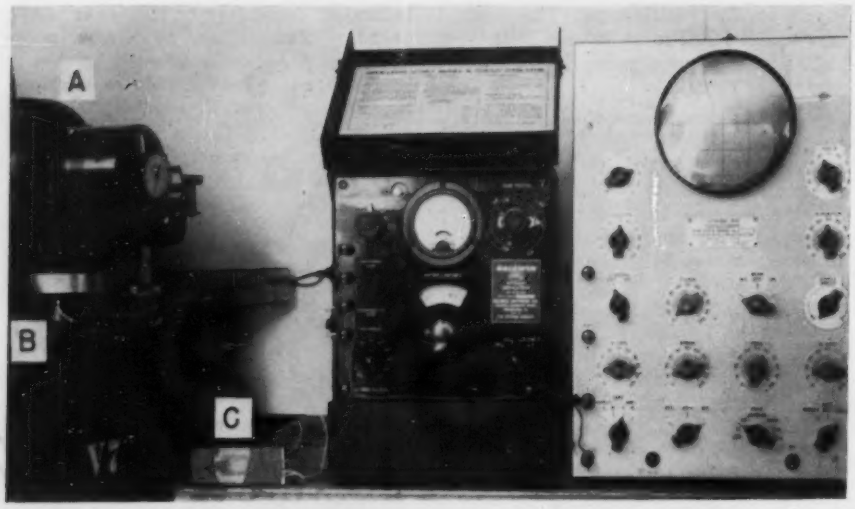

Fig. 3

minimum dynamic balance would appear the same but the slide wire setting would be different.

The complete calibration set-up is shown in Fig. 3. It includes the Krouse fatigue machine A, and fatigue specimen, B, the compensating gage, C, the Strain Indicator, and the cathode-ray oscilloscope. The leads connecting the strain indicator to the oscilloscope can be made extremely short to minimize the possibility of pick-up from other circuits. The distance between the strain indicator and the active gage can also be made quite small by proper arrangement of the test apparatus. The shorter the length of the leads, the less becomes the possibility of 60-cycle or other pick-up. The same effect could be produced by shielding the various lead wires and this precaution was taken on the lead from the strain indicator to the vertical amplifier of the oscilloscope.

The above calibration procedure has also been used for dynamic measurements on a direct tension-compression fatigue machine and on a Sonntag constant force type bending fatigue machine.

This article is not intended to imply a new application of SR-4 strain gages but rather presents what is believed to be a new adaptation of existing static test equipment for use with SR-4 strain gages under dynamic test conditions. Among the previous investigators who have conducted dynamic tests with various types of gages and auxiliary equipment, the present procedure is perhaps most nearly like the procedure described by Grover[1]. The procedure outlined by Grover supplied the inspiration which led to the development of the procedure described in this article. Others who have conducted dynamic tests in various ways are listed in the bibliography. This list is not intended to represent a survey of the available literature on the subject of dynamic testing but rather presents a few of the methods which have been devised for dynamic testing.

Acknowledgement. The writer wishes to acknowledge the assistance of the following persons at the University of Illinois who contributed to the development of this adaptation of the portable strain indicator. The SR-4 Strain Indicator used in the tests was loaned for this development by Professor C. P. Siess. Several helpful suggestions on the electronic features of the circuit were offered by Professor H. C. Roberts. The initial physical tests, using the Baldwin Southwark unit, were conducted by the writer on December 31, 1946, with the assistance of Mr. W. I. Mitchell.

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(1) "The Use of Electric Strain Gages to Measure Repeated Stresses," by H. G. Grover, *Proceedings Society for Experimental Stress Analysis*, Vol. 1, No. 1, 1943, pages 110-115.

(2) "Determination of Operating Loads and Stresses in Crankshafts," by Alexander Goloff, *Proc. S.E.S.A.*, Vol. II, No. 2, pages 139-49.

(3) "Spot Welding of Heavier Gages of Aluminum Alloys," Parts II and III, by R. C. McMaster and N. A. Begovich, *Supplement to Journal of the American Welding Society*, Vol. 10, No. 12, December, 1947, pages 644-652.

Bibliography *on* Transductors, Magnetic Amplifiers, *etc.*

Appendix to article by H. B. REX (Principal Engineer, Bureau of Ordnance, Dep't of the Navy) in our December 1947 issue. Compiled by Mr. Rex.

(1) Charles F. Burgess and Budd Frankenfield, U. S. Patent 720,884, issued Feb. 17, 1903, (application filed June 12, 1901) "Regulation of Electric Circuits." Discloses the use of a transductor to regulate an a-c. circuit. Makes no claims regarding amplifying properties.

(2) Ernst F. W. Alexanderson, U. S. Patent 1,206,643, issued Nov. 28, 1916 (application filed Dec. 7, 1912) "Controlling Alternating Currents." This basic patent is the first to indicate that the transductor could function as an amplifier or modulator.

(3) Ernst F. W. Alexanderson and S. P. Nixdorff, "A Magnetic Amplifier for Radio Telephony," *Proc. I.R.E.*, Vol. 4, April 1916, pages 101-129.

(4) M. Osnos, U. S. Patent 1,227,302, issued May 22, 1917 (application filed July 8, 1915) "Means for Controlling Alternating Currents." Discloses the method of making transductors so that high a-c. voltages are not induced in the control winding. A serious insulating problem is thus avoided.

(5) F. P. Coffin, "Improvising a Current Limiting Reactor by D-c. Excitation of a Pair of Transformers," *G. E. Review*, Vol. 20, Oct. 1917, pages 821-824.

(6) M. Osnos, "Shaltung und Bau der mit Gleichström geregelten Drosselspulen," *ETZ*, Vol. 39, 1918, pages 205-207, 216-218.

(7) E. Besag, "Messung starker Gleichstrome auf grosse Entfernung," *ETZ*, Vol. 40, 1919, pages 436-437.

(8) Ernst F. W. Alexanderson, U. S. Patent 1,328,610, issued Jan. 20, 1920, (application filed Jan. 21, 1916) "Method of and Means for Controlling High-frequency Alternating Currents." Discloses: (1) the tuned, or nearly tuned, transductor (this increases the gain), (2) the shell type of transductor, (3) a two-stage amplifier using the mercury-arc rectifier.

(9) Ernst F. W. Alexanderson, U. S. Patent 1,328,797, issued Jan. 20, 1920, (application filed Nov. 26, 1915), "Means for Controlling Alternating Currents." Discloses: (1) improvements in design of transductors, (2) the transductor made with toroidal cores, and (3) the use of self-excitation to increase the gain.

(10) Edwin J. Murphy and Louis W. Thompson, U. S. Patent 1,337,942, issued 20 April 1920 (application filed July 10, 1918), "Regulating System for Alternating Current Circuits." Discloses a method of obtaining rapid and sensitive regulation of an a-c. circuit without the use of heavy moving parts.

(11) Elmer E. Bucher, "The Alexanderson System for Radio Communication," *G. E. Review*, Vol. 23, Oct. 1920, pages 813-839.

(12) Edwin R. Stoekle, U. S. Patent 1,376,978, issued May 3, 1921 (application filed Nov. 24, 1917), "Regulator for Alternating Currents." Discloses single-phase and three-phase regulating transformers which function by means of saturable magnetic shunts.

(13) Frederick L. ReQua, U. S. Patent 1,390,543, issued Sept. 13, 1921 (application filed Aug. 19, 1918), "Current-Regulator." Discloses use of the magnetic amplifier, with the control winding shunted by a resistor or capacitor, for the purpose of controlling current to a load, shown as a lamp load.

(14) Louis W. Thompson, U. S. Patent 1,408,844, issued Mar. 7, 1922 (application filed July 10, 1918), "Speed Regulation of Alternating-current Motors." Discloses the use of the transductor for the purpose of speed regulation.

(15) Julius Jonas, U. S. Patent. 1,434,346, issued Oct. 31, 1922 (application filed Oct. 4, 1920), "Apparatus for Regulating the Voltage of Metal Vapor Rectifier Installations." Discloses the use of single-phase and polyphase transductors for this purpose.

(16) Alan Stewart Fitzgerald, U. S. Patent 1,468,441, issued Sept. 18, 1923 (application filed Sept. 9, 1922), "Protective Device for Electric Distribution Systems." Discloses use of transductors as part of remote control system to operate relays for power distribution.

(17) G. W. Elmen, U. S. Patent 1,470,965, issued Oct. 16, 1923 (application filed Aug.

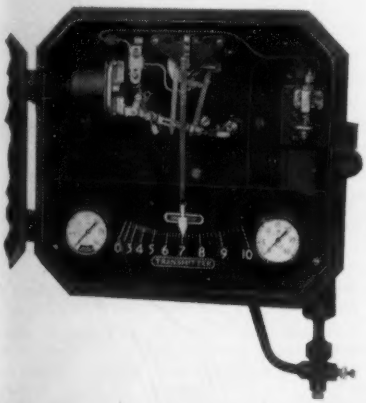
(Continued on page 352)

5 HITS - NO ERRORS

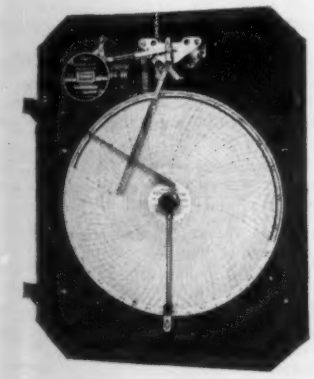
Taylor's score on these new instruments

HERE'S just a brief reminder of five Taylor Instrument developments that made news during the past year. Five entirely new departures in industrial instrumentation. That adds up to *increased production efficiency*—your best defense against today's sky-high material and labor costs. Along with our complete instrument line for indicating, recording and controlling in practically every industrial process, these five new instruments are ready to help you keep quality up and costs down. Ask your Taylor Field Engineer! Or write Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

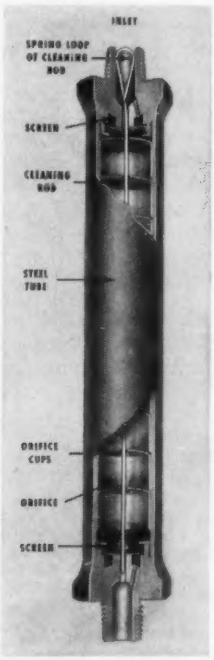
Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.



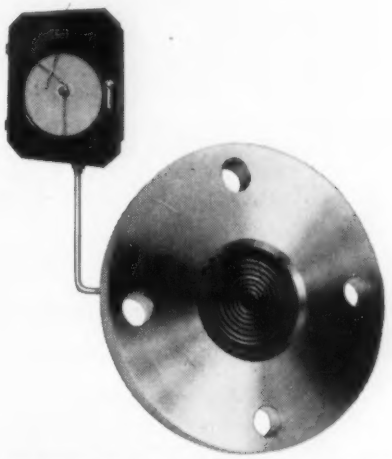
Taylor 226R Pneumatic Transmitter. Helps keep every process in your plant right under your finger tips. Accurate within ½ of 1% scale range. Gives you constant remote control of temperature, pressure, rate of flow and liquid level.



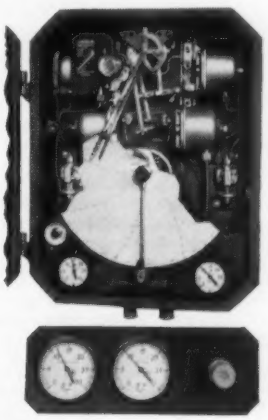
Taylor Square Root Integrator. Totalizes accurately the flow of liquids, and of gases and steam under constant pressure. Easy to read through 2 inch window in Recorder case door. Auxiliary scale and pointer for quick checking of calibration.



Taylor Pressure Pulsation Damping Unit. Damps pulsating pressure waves and gives you a *true instantaneous average of pressure.* Permits measuring instrument to make a clean-cut, easily interpreted pressure record. Makes instruments practical where they otherwise couldn't be used.



Taylor 229R Liquid Level Transmitter. Accurately measures the liquid level of slurries, soap, paper pulp, or any other viscous or corrosive liquids containing solids. Simple, highly responsive, built on force-balance principle. Ranges within 12 and 240 inches of water.



Taylor "Transet". New Pneumatic Transmission System for greater accuracy of control on applications with long lead lines between transmitter and control panel, and where compactness of control panel is a consideration for control of temperature, pressure, humidity, rate of flow and liquid level.

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

A "Historical Museum *on* Paper" *of* American Instruments *in* Science *and* Industry

(Conclusion)

EIGHTH "GALLERY"

The "Miracle *of* Production"—*and* Victory

1944 *and* 1945

1944. "We took on the sale of the 'Metricator' Dimensional Air Gage; later buying all rights to this Gage, . . . new name the 'Federalair' Gage." —I. A. Hunt, Federal Products Corp.

1944. "Palmer received a patent on the spring arrangement for holding the double-strength glass shield in the new extruded brass case thermometer, firmly, yet without strain. . . ."—A. E. Honningford, Palmer Thermometers Inc.

1944. "Dynamic simulation technique developed from mathematical concepts to permit calibration of any flowmeter for any liquid or gas service by means of any other convenient liquid or gas without correction for either density or viscosity."—Kermit Fischer, Fischer & Porter Co.

1944. "Burner Pressure Regulator for control of fuel supply to furnaces from an instrument. . . . duplex diaphragm valve contained several outstanding improved developments following a similar Belfield valve featuring only one diaphragm."—E. Wolff, Chief Engineer H. Belfield Co.

1944. "In collaboration with Stanley P. Rockwell The Bristol Co. developed a Direct-reading Dilatometer, for recording temperature-dilation and temperature-time changes simultaneous on a chart during the heating and cooling cycles."—G. P. Lonergan, The Bristol Co.

1944. "The Sperry 'Gyrosyn' Compass . . . successful combination of a magnetic compass and directional gyro. For the first time the pilot had a north-seeking compass which would not be affected by oscillation, swinging, movement of the plane or turbulence of air." —C. H. Jones, Sperry Gyroscope Co.

1944. "Electrostatic Voltmeters. . . . A completely new design . . . higher than one million megohms guaranteed insulation, and much higher voltage ranges than were previously available. . . . actually measure static electricity with suitable probes. . . . used in large numbers by the atom-bomb laboratories."—A. J. Lush, President, Rawson Electrical Instrument Co.

1944. "The First Electronic Voltage Regulators. Edward Martin Sorensen, an electronic inventor (killed June 1946 in an airplane crash) conceived during the 1930's a line of fully electronic voltage regulators. It was put on the drawing boards in 1941 and '42; developed in '42 and '43; made commercially available in January 44. . . . Among Mr. Sorensen's wartime developments . . . aerial torpedo control, servomechanisms adapted to A-3 Automatic Pilot, frequency limit controls, d-c. supplies, components for "Little Abner" radar, . . . "—Edward Einhorn, for Sorensen & Co.

1944. "The Brown Adjustable 'Indexet' was introduced. . . . similar to the Fixed 'Indexet' [1942] . . . However, it incorporates a means for adjusting the relationship between the controlled air pressure and the position of the secondary control index at the secondary controller. Thus, in effect, it determines the rate at which the secondary control index is repositioned to conform to process requirements."—C. C. Roberts, Brown Instrument Co.

Extracts from editorial in January issue introducing *Instruments'* Twentieth Anniversary Feature which began in that issue:

THIS is not a history but a "historical museum on paper." Some day a history of American instruments will be written. As a contribution to the proper preparation of such a history, this editorial introduction will recite facts and circumstances.

But before we go into these details we express deep appreciation of the tremendous amount of work done by the hundreds of contributors: Tens of thousands of man-hours in hundreds of laboratories and plants have gone into making possible this Special Issue!

THE PLAN.—Burns was right when he wrote about "the best laid plans of mice and men . . . " No finer plan could have been conceived than the one adopted last summer:

(1) The Twentieth Anniversary Issue to be a historical issue, chiefly of "FIRSTS." (In view of the modesty of many old-timers in the industry, the term "outstanding development" was used in addition to the word "first.")

(2) The issue to be made up entirely of contributions mailed to *Instruments;* no historical delving or writing by the editor, because such work would take years instead of months.

THE INVITATIONS.—Various letters and advertisements were prepared last summer, in which the plan was outlined and the simple "rules" explained. It was stipulated that EACH description was to mention WHY the development was outstanding.

"EVERYBODY" INVITED.—The mailing list included all instrument manufacturers; also instrument designers and makers in governmental and private institutions. Thousands of persons not on this list were notified through the magazine *The Instrument Maker.*

HUMAN NATURE FOILS PERFECT PLAN.—Most early contributions consisted of catalogs. The letter usually ran:

"All of our latest models are of historical importance. Look over our line; pick out items and send me a list; I'll then send you cuts or photographs.

"P.S. Submit your write-ups to me before you print them."

In mid-October a "personalized form letter" was sent to every name on the master list. Extracts:

"Some of you have sent us a mass of booklets and asked us to pick out your historic achievements. Sorry, no can do! You are the one to send pictures and to write descriptions or narratives.

"Each contribution should be SIGNED. Each description should mention WHY the development was outstanding.

"Some of you, who sent us photos and descriptions of new models just brought out, may believe that these new products are as "outstanding" as, say, the first thermometer made in America; but . . . please don't force us to assume the onerous role of censor."

The total number of contributions could not be counted because most of them were not usable, being the thousands of items in catalogs. This raw material would fill an eight-foot bookshelf, but there are two deplorable absences: (1) The absence of truly historical material from some old-established companies, whose officials chose to send us only descriptions of recent outstanding developments; (2) The absence of ANY contributions from certain companies which advertise in *Instruments* and otherwise cultivate the goodwill of *Instruments* readers; the only explanation is that their officials "leaned backward" with extreme modesty. This, too, is an inevitable manifestation of human nature.

Your editor, and The Instruments Publishing Company, Inc., hereby disclaim responsibility for assertions of priority and this disclaimer is supported by the original manuscripts. Careful as we were to preserve wordings when re-writing lengthy descriptions, we were extra-careful in such cases of "firsts": WE DID NOT EDIT SUCH ASSERTIONS AT ALL.

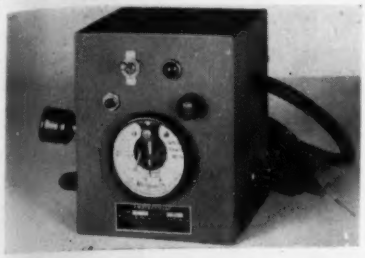
Exaggerations made as flat assertions were not edited. Similarly, when the description of an original model was accompanied by a photograph (of what looks like a modern model but is) PLAINLY MARKED WITH THE YEAR OF THE ORIGINAL, we unquestioningly used this photograph.

Seldom does *Instruments* comply with requests that its "write-ups" be "submitted for approval" before being printed. This time, such requests did not even draw replies.

Many writers included in the description of one specific development numerous explanations of its importance to the design of later developments, not dated and for which no SPECIFIC descriptions were written. Inexcusable as this was, we extracted all we could from these meandering stories for inseration under later dates.

Most of the raw material as received was—well, terribly raw. To correspond individually with all these writers, returning their contributions and offering suggestions, would have meant more than two thousand hours of supplemental editorial work. Special letters asking for essential data such as dates, etc., were sent by an assistant who enclosed copies of the rules. These simple inquiries should have drawn 100% replies; they did not! Even then, we did not discard unusable contributions: we MADE them usable whenever possible! How? That, dear friend, is a secret—which you could have learned if you had dropped in between 1 and 4 a.m. on many a wintry night! —MFB

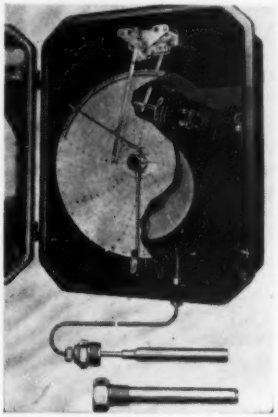
1944. "First recorded sale of Foxboro 'Dewcel,' a humidity-sensitive element of completely new principle and design in industrial equipment. . . . the first simple, economical and dependable method for continuous dew point measurement and control."—Robert Barton, The Foxboro Co.



1944. "The 'Protectovac,' a protective device which operates a control circuit when the pressure in a vacuum system exceeds a certain pre-set limit."—Stanley Heck, National Research Corp.

1944. "The 'Type 706' Thermocouple—Ionization Control . . . covers the pressure range from 2×10^{-7} mm. to 1 mm. of mercury." — Stanley Heck, National Research Corp.

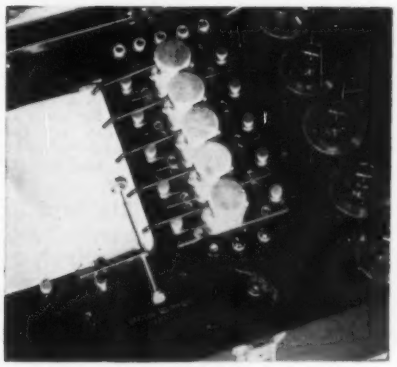
1944. "Amineo-Dunmore Electric Hygrometer, a system for measuring, controlling, and recording relative humidity. Heart of system is the 'H-2' sensing element conceived in 1939 by Dr. F. W. Dunmore of the NBS. In 1944 this Company was granted the right to develop it (see illustration) . . . and suitable indicating, controlling, and recording equipment for industrial applications . . . Made possible the following outstanding advancements in the field of hygrometry: (1) Humidity readings reproducible over a period of years; (2) Microchanges as small as 0.1% relative humidity can be detected; (3) Speed of response to changes in relative humidity *for decreasing as well as increasing moisture content* is less than one second; (4) It neither adds nor subtracts an appreciable amount of moisture from the space . . . consequently, true readings of relative humidity are obtained, even in sealed spaces . . .; (5) Humidity-sensing element separate from measuring equipment; therefore, suitable for use in remote installations and in applications requiring sensing element to be sealed in pressure systems or in small packages."—C. L. Schuettler, American Instrument Co.



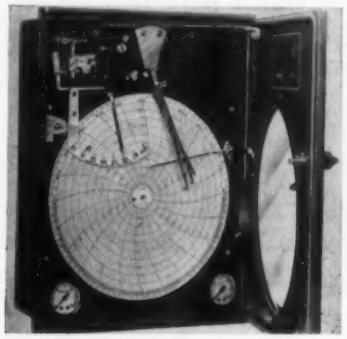
1944. "Recording Thermometers . . . intensive research . . . Taylor-developed 'Accuratus' mercury thermal system gave more positive actuation and greater compensation for temperature changes . . . long lengths of capillary."—C. S. Conner, Taylor Instrument Companies.

1944. "Originally designed as a safety device in motor vehicles, 'Pressure Clix' has since developed into . . . the outstanding pressure switch of the day..." —E. C. Hawke, The Nason Co.

1944. "Both sensitivity and accuracy are obtained with the portable wind-speed and direction indicator developed at the NBS under Navy Dep't. sponsorship. The propeller (at right) is forced to head into the wind by the vane (upper left). Rotation of the propeller causes the dial of the magnetic-drag tachometer (just below the vane) to register wind speed in knots or mph. A pointer turns with the vane to indicate wind direction in degrees on the horizon disk below the tachometer." —Hugh Odishaw, National Bureau of Standards.



1944. "Oscillograph mechanism of Garceau Electroencephalograph improved to provide much larger linear travel as well as higher frequency response. Industrial and ordnance direct-writing oscillographs, known generically as the Garceau 'Velograph,' . . . many of them provided with amplifiers, some direct-coupled."—Lovett Garceau, Electro-Medical Laboratory, Inc.



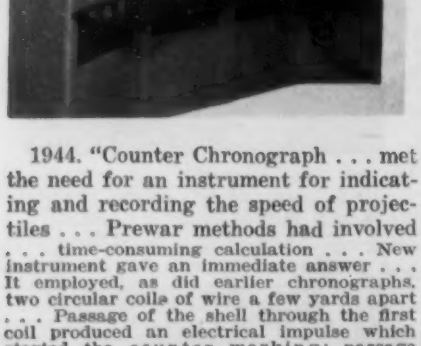
1944. "The Brown air-operated ratio controller made possible the maintenance of one variable at a predetermined ratio to another. . . . provisions for changing the desired ratio over a relatively wide range. . . . basically a two-pen recorder with pneumatic control provisions on the pen of the secondary variable. Its control index is actuated by the output air from the pneumatic transmitter of the primary variable which also actuates the pen for recording the primary measurements."—C. C. Roberts, Brown Instrument Co.

1944. "Surface Roughness Standards —representative samples depicting typical finishes arranged in orderly steps of roughness—solved the problem of how to select, specify, and obtain desired surface finishes for machine-tool work. . . . The design engineer can select and specify the degree of roughness required; the machine-tool operator can compare the result of his work with the specification; and the inspector can check the finished product

when the machining has been completed. Each has a standard surface-roughness specimen set consisting of ten metal blocks, each 2" × 2½". Each block is identified by a letter and represents a certain degree of roughness. Any of the sample blocks can be removed from the box easily and held close alongside a machined surface for comparison of the degree of roughness. All comparisons are made by sight-and-feel methods."—C. J. Falk, Gen'l Eng'g and Consulting Lab., General Electric Co.

1944. "The 'Model 80 Standard Signal Generator' . . . output metering circuit that was an innovation . . . frequency coverage of 2 Mc. to 400 Mc. in six overlapping bands . . . individually-calibrated direct-reading dial; AM continuously variable from 0 to 30%; internal 400 or 1000 cycle audio oscillator; . . . provision for application of pulse modulation . . . became a standard of test equipment for many manufacturers."—E. M. Weed, Measurements Corp.

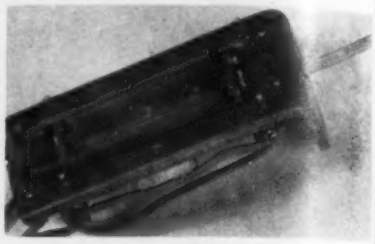
1944. Time Comparator. "Our chronometers were so accurate that they made former timing practices at the Naval Observatory seem crude and clumsy. By July of 1944 we had developed for factory use an electronic time comparator that enabled us to detect variances of rate down to 1/100 second. The Naval Observatory quickly ordered these to replace their older method of checking rate variations dial readings," R. Waddell, Hamilton Watch Co.



1944. "Counter Chronograph . . . met the need for an instrument for indicating and recording the speed of projectiles . . . Prewar methods had involved . . . time-consuming calculation . . . New instrument gave an immediate answer . . . It employed, as did earlier chronographs, two circular coils of wire a few yards apart . . . Passage of the shell through the first coil produced an electrical impulse which started the counter working; passage through the second coil stopped it. Duration was counted in cycles of a current supplied by a constant-frequency generator. Time intervals could be measured to 1/100,000 of a second. Inter-coil distance being known, the counter chronograph translated the time into speed of flight, displayed this information electrically on an indicator board and typed it on a permanent record chart. The first was put in service early in the war at Aberdeen Proving Ground. A number of others were made for use elsewhere."—E. D. Cook, Gen'l Eng'g and Consulting Lab., General Electric Co.

1944. "Dynamic strain recording prior to 1944 was an involved procedure, requiring elaborate apparatus. Is was essential that dynamic strain recording be done in fighter aircraft . . . space severely limited . . . operator of equipment had to operate the airplane . . . entire system was simplified and condensed into a small and simple portable self-powered . . . 'Type MRC-12 Strain Gage Control Unit.' . . . only 4½" high, 9" wide, 17¾" long, all of the apparatus needed except the strain gages and the oscillograph . . . a complete strain-analysis laboratory."—C. M. Hathaway, Hathaway Instrument Co.

1944. "Supersensitive Comparator Gage . . . easily show size comparisons to one millionth of an inch and less. Demand was strong for use in gage-block work and even for inspecting many components used in the war. At the time, the methods of making reliable size comparisons to this order of magnitude involved the use of complex optical methods which were not adaptable in most instances. This development followed quite naturally from the earlier development of the Metron multiple-range comparator gage (1943) which incorporated a circuit basically suited for very high sensitivities . . . a magnification ratio of 100,000× was entirely practical . . . still without employing vacuum-tube amplification. This spread out one microinch of spindle movement to 0.1" on the scale . . . easy reading to ½ microinch . . . no external sensitivity adjustment was necessary since the magnification was stable over very long periods of time. This was a necessary requirement because gage blocks are not available in small enough size increments to be used by the customer to make magnification calibrations. A unique cantilever beam calibrating procedure was developed to insure accurate calibration before shipment . . . identical in appearance to the 'Model 20' (see 1943) except that all heat-producing components are mounted in an external case. Work with this extremely sensitive comparator gage revealed that comparator gaging technique ordinarily used were not satisfactory when measuring to microinches tolerances. It was found that flat anvils, no matter how flat and clean, were not reliable. Consequently a line of point type anvils was developed for both flats and rounds of almost all shapes. Temperature control of the parts being measured and of the gage itself assumed ten times the significance. Surface finish and deformation of the work likewise had to be given more consideration. New operating techniques designed to take these factors into account were worked out to provide quick and accurate results."—F. K. Floyd, President, Metron Instrument Co.



"1944 saw continued efforts by Statham Laboratories to construct an unbonded strain-sensitive resistance wire strain gage suitable for use in pressure transmitters, dynamometers, accelerometers [etc.] . . . A gage unit (illustrated) was perfected which consists of a fixed frame or base and a driven armature (center) to which are attached four windings of the strain sensitive wire connected as the four arms of a normally-balanced Wheatstone bridge. With force or motion applied to the armature through the driving pin (right two of the windings increase in resistance while the other two decrease, unbalancing the bridge. The output is directly proportional to the force or motion. The use of four active windings provides two great advantages: (1) the output is increased fourfold over that obtainable with only one winding; (2) since all windings and their mountings are at the same temperature, temperature-change drift is cancelled out. . . . Increase in sensitivity and safety factor results from the separation of the strain-sensitive wire from a stressed surface. Low stress in the primary element is not incompatible with maximum bridge output. For example, a diaphragm stressed to 10% of its yield point may be coupled to the unbonded strain gage in such a manner as to produce the full permissible armature movement . . . a simple, yet accurate, means of transforming such variables as pressure, flow, force, acceleration and motion into an electrical signal. Dry batteries and a galvanometer or microammeter comprise the minimum requirements for a complete system. In most instances, no amplifiers or other electronic equipment is required, resulting in a saving of space, weight and cost . . . the unit is versatile . . . but may be used with an extremely wide selection of instruments, frequently eliminating the necessity of purchasing new equipment."—R. D. Meyer, Statham Laboratories.

1944. "Automatic control of testing machine operation by means of Baldwin's 'SR-4' bonded resistance wire strain gage was introduced with the 20,000-lb. capacity Sonntag 'SF-20-U' fatigue testing machine. . . . The control circuit holds within close limits the speed of the motor that drives the eccentric mass and applies the constant force. This machine is also outstanding for the large size of parts that may be tested . . . 48" between surfaces of fixed and adjustable platens."—M. G. Van Voorhis, for Baldwin Locomotive Works.

1944. "A radically new tachometer and speed-measuring system was developed which gave promise of application for all types of tachometers . . . a capacitor connected by means of a polarity-reversing switch in series with a voltage source and an indicating element (see Fig. 1). The success of this

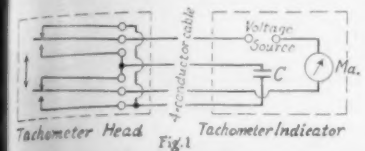


Fig. 1

system vitally depended upon a reliable polarity-reversing switch which, of course, served as the speed-sensitive element or head. Such a head element was developed (Fig. 2) which would run at a speed of at least 10,000 rpm. and for a total of at least 2.5 billion revolutions without maintenance or change in performance accuracy. The first commercial embodiment of this principle was 'Type 45A' Hand Tachometer (Fig. 3) which in-

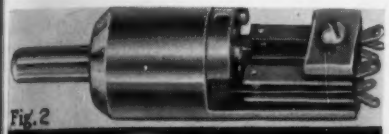


Fig. 2

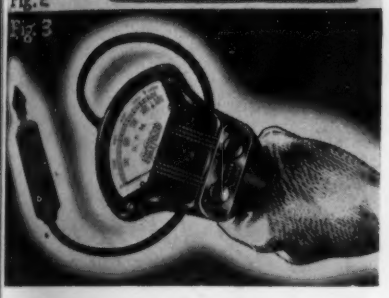


Fig. 3

corporated many features rarely found in earlier hand instruments: isolation of vibration from the indicator, indestructibility due to overspeeding or changing ranges while in operation, low driving torque, wide speed range (200 to 10,000 rpm.) and long maintenance-free life . . . employed a standard-size flashlight cell as a voltage source and a circuit to easily adjust for changes in battery voltage. A second head was then developed that would provide ten polarity-reversals for each head shaft revolution . . . similar to Fig. 3 but used a positive tensioned sinusoidal cam . . . introduced a new low-speed tachometer (20 to 1000 rpm) . . . attention was then given to a line of fixed-installation tachometers based on the same principle but for operation from system power and equipped with voltage regulators . . . A series of tachometer heads (using the same basic element, Fig. 2) was developed for fixed-installation applications . . . by means of gear trains built into the heads . . . was found practical to supply direct-coupling heads for speed measurements as low as 1 rpm. or 5" per minute for full-scale deflection. This was an important contribution to the field of speed measurement . . . It was found that this basic system of speed measurement was admirably suited for multiple head monitoring of many different machines by using a single indicator and a selector switch system. Since accuracy does not depend on wear or adjustment of the head contacts (within wide limits) the heads are interchangeable and it is not necessary to compensate sensitivity in switching from one head to the next . . . the circuit being of a constant current type, introduction of resistance (within limits) does not affect calibration . . . This permits the use of a wide range of cable lengths and types) between indicators and heads. Speed recording and controlling components have subsequently been employed to a good advantage using the same basic system."—F. K. Floyd, President, Metron Instrument Co.

1940-1945. "This organization was formed in 1940 to make available to American industry radioactive materials, particularly radium, in amounts to meet the demand, and at a price far below the prevailing one. With the advent of the war, we immediately met the situation by supplying previously unheard-of quantities of radium for non-destructive testing of casts, welds, etc., vital to war production. Facilities were set up to produce luminous compounds for instrument dials, etc. . . . We supplied the Uranium necessary for the Manhattan Project's work (Smythe Report 6:10). We were successful in producing Polonium on a commercial basis, and this, as well as radium, was utilized in the preparation of neutron sources essential in nuclear research and operation. . . . During this time, we maintained a Research Division of the highest calibre. . . . developed a number of outstanding instruments now serving industry. Among them are a Portable Geiger Counter weighing 4 lbs. suitable in tracer work and finding wide use in the oil industry; a Radioactive Torsion Indicator; a Radioactive Liquid Level Indicator; a Radioactive Relay; a Radioactive Condenser Resistor; a Radioactive Switch; a Polonium Integrator which will instantaneously measure by direct reading irregular surfaces of any thickness; a Radioactive Micro-Balance which will weigh to 1 microgram and can be read directly from an electrical indicating instrument, [etc.] . . ."—Henry Wolfson, Coördinator of Research, Canadian Radium & Uranium Corp.

1941-1945. ". . . gun sights for U. S. Navy, both of Navy design and our own design . . . numerous Ordnance items, some of which we developed . . ." —J. A. Stein, Chief Engineer, Bacharach Industrial Instrument Co.

1941-1945. "During this period occurred the greatest spread of 'catalog type' of Indicating Gages for inspecting every type of physical dimension. There also was a tremendous spread in the Special Gage designs."—I. A. Hunt, Federal Products Corp.

1942-1945. " 'Dynalog' instruments utilized exclusively for highest priority stress analysis work in the design of ships, naval guns, planes and structures."—Robert Barton, The Foxboro Co.

1942-45. "Through new production techniques Sylvania Electric became major producer of entirely new subminiature electron tubes for wartime proximity fuses. Approximately 15,000 people were employed producing 400,000 Sylvania subminiature tubes daily in August 1945."—E. C. Thompson, for Sylvania Electric Products, Inc.

"1942 to 1945. After Pearl Harbor, the engineering facilities of the Bristol Company were devoted entirely to developing special instruments and control devices for the U. S. Army and Navy and to the improving of earlier developed automatic controlling, recording, and indicating instruments in the Bristol line for use in war-production plants . . . Accelerometers for Navy dive bombers; air-speed gages and wing tank gasoline gages for fighter planes; a system of cowl flap control for airplane engines and the necessary instruments for its use; . . . developed several special Diesel engine pyrometers and thermocouple assemblies for the Navy and furnished a substantial portion of Diesel engine pyrometers used on . . . [ten types of craft]. . . . helped perfect the Bathythermograph, a component of Sonar . . . built a large number of instruments for the atomic bomb projects . . . A number of instruments were developed for use in engine rooms of troop and cargo vessels and for the operation of floating dry docks . . . Engineering development work on numerous confidential projects for the armed services . . .During American industry's plant expansion and tooling-up period in preparing for production of war goods The Bristol Co. furnished many of the automatic controlling and recording instruments required for the manufacture of such essential materials and equipment as [long list] . . . as well as other materials for use in war equipment."—G. P. Lonergan, The Bristol Co.

1945. "The first 'Dynalog' Recorders and Controllers were available for use in process industries."—Robert Barton, The Foxboro Co.

1945. "Federal brought out the 'Model 1340' Indicating Snap Gage which superseded the old style snap gage."—I. A. Hunt, Federal Products Corp.

1945. "In November 1945 we developed and made chronometers with the first second-setting mechanisms." — R. Waddell, Hamilton Watch Co.

1945. "Woven glass diaphragms not affected by most gases and vapors — Askania Fiberglas Diaphragms." — T. M. Lowe, Askania Regulator Co.

1945. "Construction of the Garceau Electroencephalographs was resumed and instruments up to eight channels were designed."—Lovett Garceau, Electro-Medical Laboratory, Inc.

1945. "Browning 'A Scope' Developed for War Purposes . . . one of the most compact . . . included in many Government radar installations." — G. H. Browning, Browning Laboratories.

1945. "We brought out the Federal Indicating Micrometer, graduated in 0.0001", equipped with built-in Dial Indicator. First and only in this country." —I. A. Hunt, Federal Products Corp.

1945. "Combustibles Recorder . . . electronic-type recording instrument and catalytic-combustion-principle analyzer . . . recording the percentage of combustibles in a gaseous mixture."— E. B. Bossart, Bailey Meter Co.

1945. "The Bristol Co. developed the instruments used in 1946 during the Bikini atomic bomb tests for measuring and recording the intensity and magnitude of the wave formations taking place on the ocean surface during and immediately after the bomb explosions." —G. P. Lonergan, The Bristol Co.

1945. "Many small but important developments were made in the Statham Gages in this year, expanding their field of usefulness by providing a reliable instrument yielding accurate measurements in the hands of operators with but little technical knowledge."—R. D. Meyer, Statham Laboratories.

1945. "The Bristol Running-Time Recorder, . . . for machines, pumps, presses,

etc. The readings are magnified on the chart in such a way that either total machine running-time or down-time can be easily and accurately determined to within a few seconds. . . . extremely valuable in making production studies."—G. P. Lonergan, The Bristol Co.

1945. "A new all-glass filter pump with check valve was developed. (. . . pumps on the market gave variable results . . .) The new pump has closely-held dimensions and a minimum capacity of 6.5 liters per minute of free air with 40 lbs. water pressure. The check valve prevents backing-up of the water with low or variable pressures."—J. J. Moran, Kimble Glass.

1945. "Hard-faced seating surfaces were adopted as standard for all Leslie reducing valves, pump governors, temperature regulators and diaphragm regulating valves for use in steam service regardless of pressure or temperature conditions . . . the only line of regulators which incorporates this quality feature as standard practice whether or not specified."—John S. Leslie, President, Leslie Co.

1945. "Development of the electronic journal system by Minneapolis-Honeywell . . . Fundamentally, . . . an electronic bridge circuit which is unbalanced by a rise in temperature beyond a predetermined setting at any of the resistance bulbs . . . Signal can be in the form of a hot journal-alarm light, an electric horn or bell, or the train's signal line actuated by an electrically operated valve."—C. C. Roberts, Brown Instrument Co.

1945. "During this year we were the first concern and still are the only concern to educate and promote the use of Statistical Quality Control methods. We have up to the present time conducted some nine Quality Control Conferences where upwards of fifty men from plants all over the country attend a training course five days in sequence on the practical aspects of Statistical methods."—I. A. Hunt, Federal Products Corp.

1945. "A line of packless diaphragm-motor valves for service where it is imperative to avoid leakage of the control fluid. . . . typical example, the valve was not only packless but was also steam-jacketed, the bellows chamber was equipped with an auxiliary stuffing box, . . . Valves of similar design in simpler form had been developed by Belfield as far back as 1936 for refrigeration, air conditioning . . . "—E. Wolff, Chief Engineer, H. Belfield, Co.

1945. "Leslie 'Class HS' self-contained internal-pilot piston-operated Reducing Valve for inlet steam pressures to 1500 lbs./in.^{2}, 1000°F. . . . for high-pressure . . . power plants . . . outstanding in the use of a combination of materials which resist corrosion, erosion and galling under these conditions, featuring hardened stainless steel wearing parts, integral hard-faced seats and corrosion-resistant springs."—John S. Leslie, President, Leslie Co.

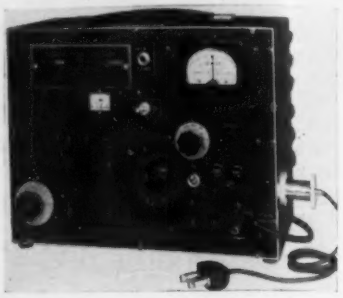
1945. "Brown engineers developed the 'Air-o-Larm' system. . . . explosion-proof housed switching arrangement for controlling electrical circuits at pre-set pen positions of the process controller. The system consists of two assemblies interconnected by small-diameter copper tubing. One assembly . . . in the case of the process controller. . . . The other assembly, . . . in an explosion-proof housing, comprises two bellows which actuate mercury switches."—C. C. Roberts, Brown Instrument Co.

1945. "Small-size Gyro Instruments. Two 'baby' gyros, only 3¼" square, were developed for operation of an automatic pilot. They were the directional gyro and a gyro horizon (bank-and-climb gyro) . . . New directional gyro weighs 1 lb. less than the old unit; continues to function smoothly without being reset even after plane has gone through violent acrobatics; actually functions as if it had universal freedom of motion—a new achievement. New gyro horizon weighs 6 lbs. less than instrument it replaces, . . . operation also superior to predecessor."—R. Faille, Apparatus Dep't, General Electric Co.

1945. "Our company was organized to develop and manufacture Electric Speed Indicators based on frequency pulses. During 1945 we introduced our Portable and Panel Type Indicators . . . [For use where no electrical frequency is available] we developed several frequency sender units which operated either magnetically or mechanically from movable part . . . based their accurate operation on our high-speed (500 cps.) relays and dry-cell power. . . . Added voltage regulators allowing use of our Indicators on line power with variations of 100 to 140 volts or battery variation of 5½ to 8 volts. . . ."—V. L. Westberg, Westberg Mfg. Co.

1945. "The High-speed Electronic Torquemeter measures and indicates the torque transmitted by a rotating shaft by measuring the angular twist in a definite length of the shaft . . . The output signals of two pick-ups attached to the shaft some distance apart undergo a relative phase shift owing to the twist imposed upon the shaft by the torque. This phase shift is measured and is indicated in terms of the torque required to produce it. The pick-ups utilize the change-of-capacitance principle . . . construction lends itself well to high-speed operation, obviates need for slip rings or other type of electrical couplings with the rotating member. By means of a unique phase-measuring circuit the difficulties usually encountered in phase-measuring torquemeters have been eliminated or minimized because the indication does not depend upon the amplitudes or the harmonic content of the generated signal but depends solely upon the point at which generated signal goes through zero."—R. K. Fairley, Gen'l Eng'g and Consulting Lab., General Electric Co.

1945. "The 'Type 5RP' Cathode-ray Tube . . . a high-voltage tube which incorporates an intensifier subdivided into several steps. Chief advantage of '5RP' over present cathode-ray tubes is its ability to operate at higher intensifier to second anode voltage ratios. This feature permits the use of much higher over-all accelerating voltages with deflection sensitivities only slightly less than heretofore obtainable in low-voltage c-r. tubes. . . . The tube has a cylindrical body and the deflection plate and second anode connections are made through the neck instead of through the base. Low-capacitance deflection plate leads facilitate high frequency operation. . . . In this same year the Type 5SP' Cathode-ray Tube was produced . . . a two-beam cathode-ray tube having completely independent gun and deflection plate structures . . . to present two related or entirely independent phenomena on a single c-r. tube screen for simultaneous observation and comparison."—J. H. Ruiter, Allen B. DuMont Laboratories.



1945. "When announcement of moving the FM band . . . Measurements Corp. again was the first . . . 'Model 78-FM' measurements of satisfactory accuracy within the output range of 1 microvolt to 0.1 volt with extremely low distortion . . ."—E. M. Weed, Measurements Corp.

1945. "An immersion pyrometer operating on the total radiation principle used in Rayotube Pyrometers, and suitably rugged for steel mill use, was developed by L&N for measuring the temperature of open-hearth baths during the heat. This instrument now makes it possible for open-hearth helpers to get accurate, reliable measurements of bath temperature prior to tapping. With this information, they have been able to reduce ladle skulls, avoid ingot stickers and in general take the guesswork out of one of the most important phases of steel-making."—H. M. Parshall, Leeds & Northrup Co.

1945. "The Differential Analyzer placed in operation at the University of California in Los Angeles followed the design of the initial instrument which G-E had built for its own use several years before . . . problems involving radar, hydrodynamic flow, rotating ma-

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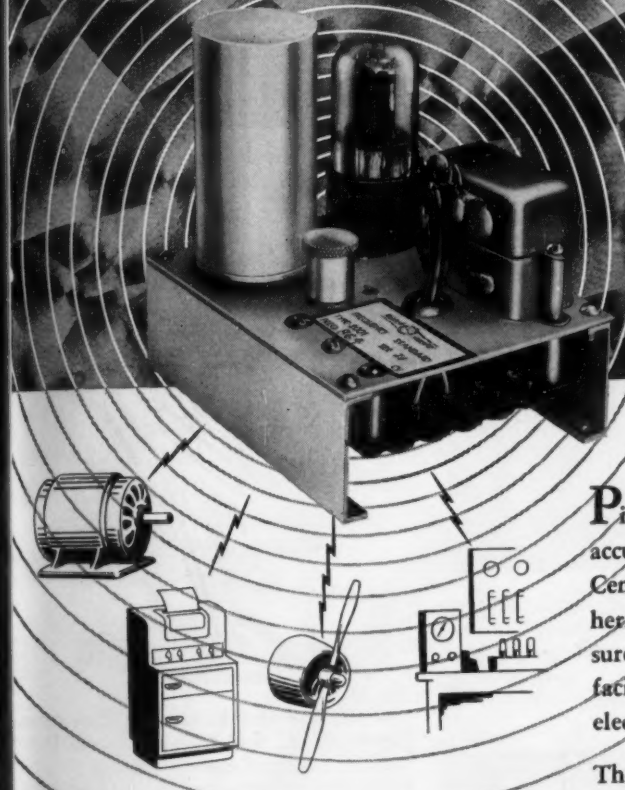
ANY FREQUENCY FROM 40 TO 1,000



Pictured here is a tuning-fork frequency standard with accuracy guaranteed to one part per million per degree Centigrade. The fork is temperature-compensated and hermetically sealed against variations of barometric pressure. This standard, when combined with basic equipment, facilitates accurate speed and time control by mechanical, electrical, acoustical or optical means.

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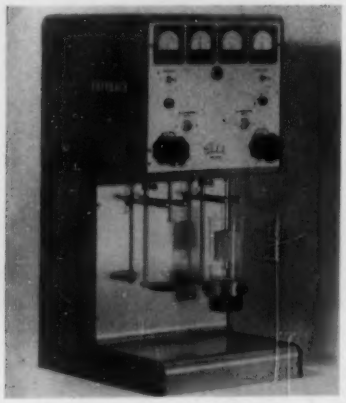
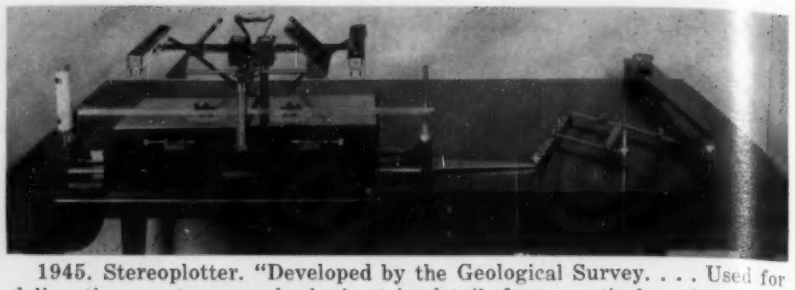
chinery, airplane stresses, and speed governors . . . recently used in obtaining trajectory data required for firing V-2 rockets at White Sands, N. M. . . ." —H. L. Clark, Gen'l Eng'g and Consulting Lab., General Electric Co.

1945. "The Sonntag impact machine for Izod, Charpy, and tension impact tests . . . provision of a range of weights and hammers that permit two methods of changing the capacity of the machine. This makes possible greater sensitivity over the whole useful range of the machine. A slotted and ground base simplifies the use of special fixtures for other tests."—M. G. Van Voorhis, for Baldwin Locomotive Works.

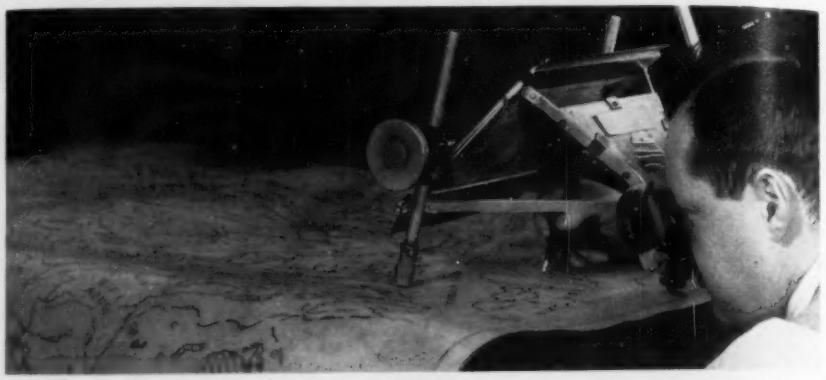


1945. "The re-designed Electro-Analysis Apparatus, streamlined in design, incorporated a number of advances to insure longer life and better operation." —L. W. Bittman, Eberbach & Son Co.

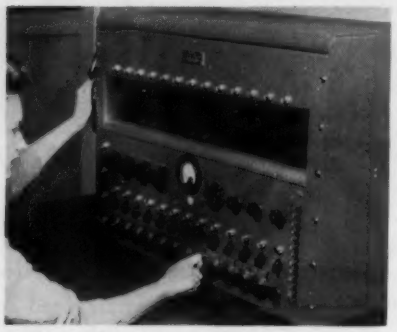
1945. "Development of 'Ratotronic' electronic transmitter and remote receiver extended use of recording or totalizing or controlling flowmeters into new low flow ranges, not hitherto meterable, down to as low as 1.0 milliliters liquid per minute." — Kermit Fischer, Fischer & Porter Co.



1945. Stereoplotter. "Developed by the Geological Survey. . . . Used for delineating contours and planimetric detail from vertical aerial photographs."—W. E. Wrather, Director, Geological Survey, Dep't of the Interior.

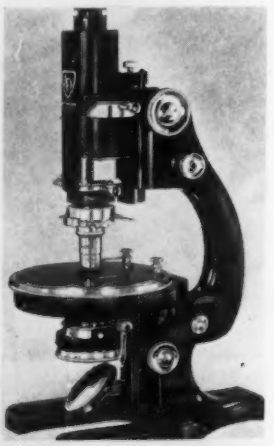


1945. The Sketchmaster. "Developed by the Geological Survey. . . . Used for transferring detail from the aerial photograph to the map."—W. E. Wrather, Director, Geological Survey, Dep't of the Interior.

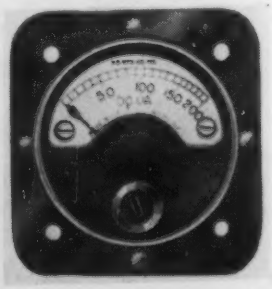


1945. "First model of the Consolidated Electric Computer was shown . . . solves twelve simultaneous linear algebraic equations at one time . . ."—G. E. West, Consolidated Engineering Corp.

1945. "The 'Alphatron,' an all-metal ionization type vacuum gage with an effective range of 1 micron to 10 mm. of mercury. Alpha particles from a radium source are the ionization agents. Calibration charts enable the operator to read pressures of gases and mixtures of gases as well as of dry air."—Stanley Heck, National Research Corp.

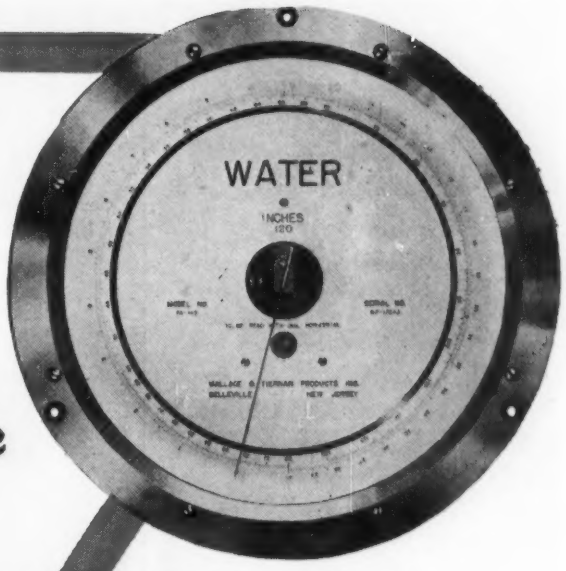


1945. "Spencer Polarizing Microscope 'Model 42AC' was designed to use Polaroid in place of calcite prisms . . . results compare favorably in extinction . . . substantial saving in cost of instrument."—J. V. Cockin, American Optical Co.



1945. Sub-miniature electrical instruments. "The Instrument Division of the M B Mfg. Co. (now International In-

Like a Sixteen Foot Liquid Column in an Eight Inch Case



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Range ..... up to 200 inches of mercury gauge or differential

Accuracy ..... 1 part in 1000

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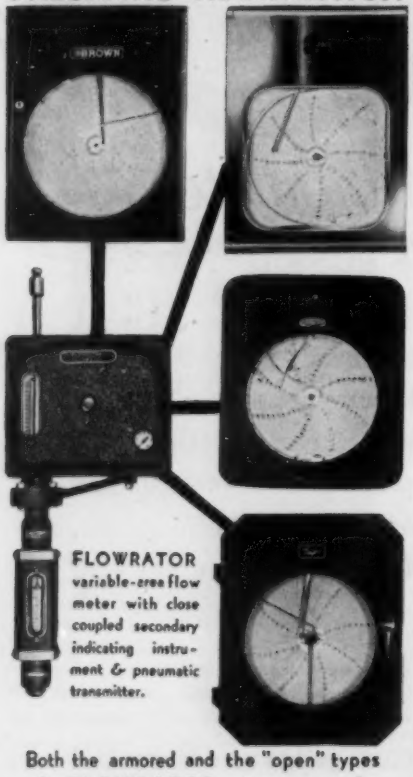

FLOWRATOR variable-area flow meter with close coupled secondary indicating instrument & pneumatic transmitter.

Both the armored and the "open" types of FLOWRATOR instruments for measuring fluid flows are available with pneumatic transmitters used to actuate the remote receivers made by any of the better-known instrument manufacturers. No coordination of the instruments before shipping is necessary. All you need to do is connect the air lines and adjust one screw in the transmitter till the readings of transmitter and receiver agree.

The F & P pneumatic transmitter is the most modern and simple available. Both the pilot and the relay valve are built together as one single unit. That is why the transmitter case is so small though it includes a full 5" long indicator scale.

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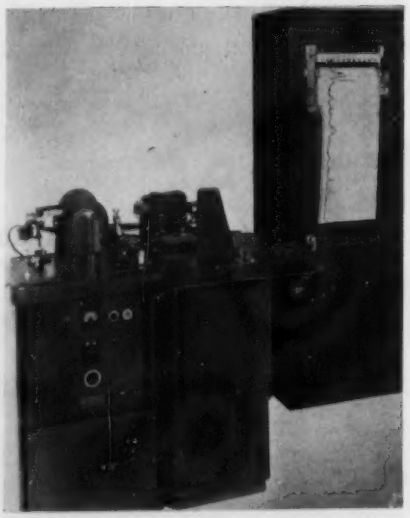
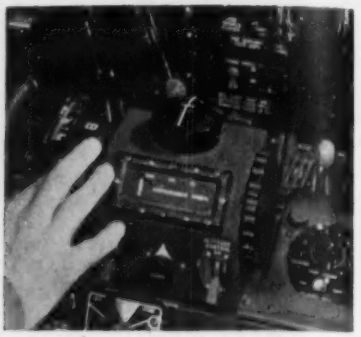
struments, Inc.) developed the 'Midget Meter,' the smallest d'Arsonval instrument on the market. It can be mounted in a one-inch diameter opening. It has found application in equipments requiring conservation of space and weight . . . Aircraft equipment manufacturers, for example, use 'Midget Meters' on radio compasses, automatic pilots. . . ."—H. H. Graham, for International Instruments, Inc.

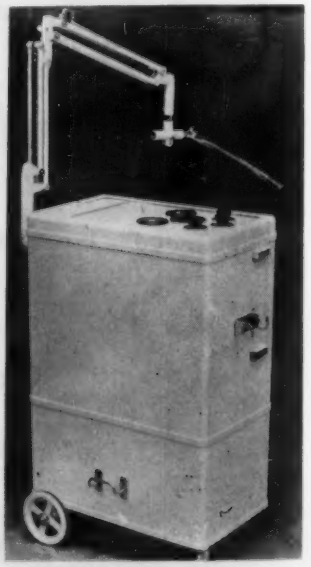
1945. "Development of 'Thermo-Clix,' an immersion temperature switch, incorporating a fully dependable snap-action feature which enables the unit to control and indicate temperatures in all immersion thermostat applications. . . ."—E. C. Hawke, The Nason Co.



1945. "The 'Norelco' Geiger-Counter X-Ray Spectrometer, which draws analytical curves automatically on its strip-chart recorder. . . . First commercially-available . . . Small synchronour motor, through gear and clutch arrangement, slowly moves the Geiger-Muller tube over the graduated quadrant. In so doing, the tube picks up x-radiation and the intensities create a hill-and-valley curve on the chart. . . . Philips engineers simplified and perfected x-ray diffraction equipment to make it extremely practical for industrial control and analysis. . . . Addition of the automatic recorder [made it] capable of even greater accomplishments in the fields of food, drugs, chemicals, metals and plastics. . . . [Before 1945] Philips also was first to make a practical end-grounded x-ray diffraction tube; to use Straumanis technique camera for x-ray diffraction; to produce a low-angle scatter camera; to build a 4-window x-ray diffraction tube; to utilize full-wave rectification for x-ray diffraction; to produce x-ray tubes with low-absorption windows; to make water-cooled x-ray tubes rapidly interchangeable; and to produce the Geiger-Counter X-ray Quartz Orientation Apparatus."—V. W Palen, North American Philips Co.

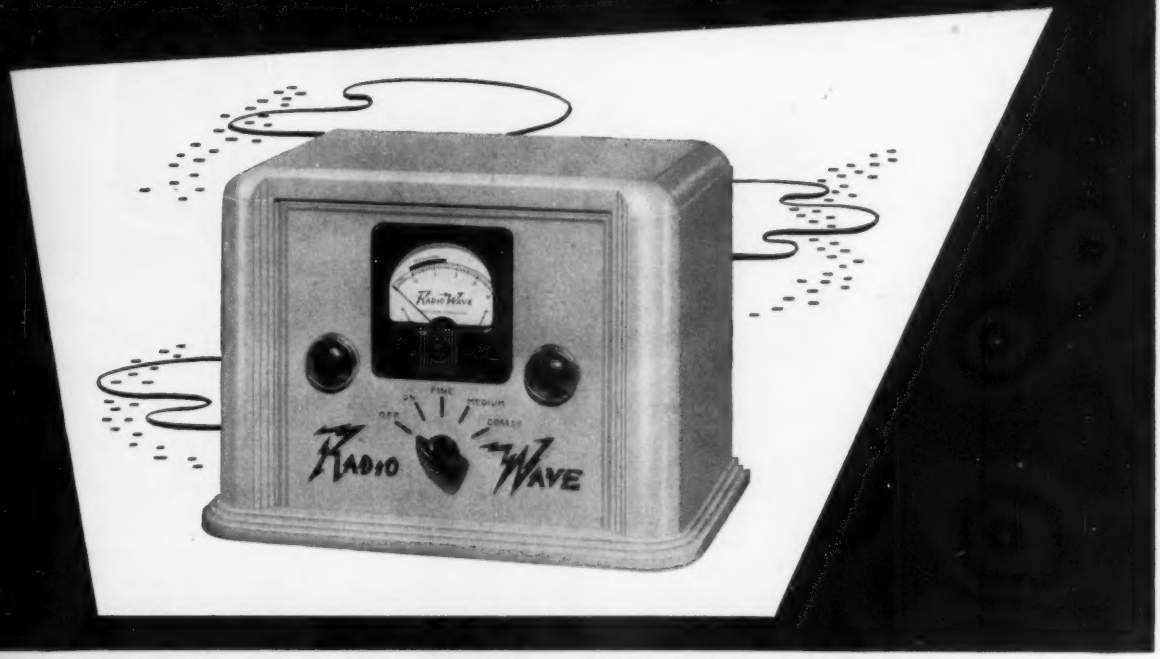


1945. "Sperry introduced the first all-electric gyropilot as the 'A-12' Gyropilot. The most efficient pilot not only performs as an aircraft stabilizer while in flight and permits automatic flight between terminals, but also provides dead-beat directional control, automatic coördination of turn and bank, automatic control of altitude and of elevator trim. . . . Photo shows United Mainliner pilot operating the pedestal controller of the 'A-12' gyropilot."—C. H. Jones, Sperry Gyroscope Co.



1945. "The 'Philips Metalix Contact & Cavity X-Ray Unit' . . . designed especially for x-radiation of body surfaces and cavities . . . Internal construction of the tube . . . provided an extremely intense x-ray beam with low inherent filtration—a notable achievement in design. The anode produced

MARION'S "SPECIAL" SALESMAN WINS ANOTHER CLIENT . . .



Builds CONSUMER CONFIDENCE In Radio Wave's Precision Permanent

A Marion "special" gives the Radio Wave Precision Permanent the critical accuracy that brings consistently fine results . . . constantly expanding sales . . . unqualified consumer confidence.

Prospective customers can *see* the Marion "special" indicate when the chemical change in the hair has reached the point where optimum results may be obtained from this revolutionary permanent wave machine.

The "special" Marion Meter designed for Radio Wave is connected in series with electrodes that transmit variations in electrical resistance occurring inside the cortex of the hair to the Marion Meter which indicates the change . . . reveals the correct waving time for perfect results.

The Marion "special" has contributed immeasurably to the extensive consumer acceptance Radio Wave is enjoying. Let Marion "specials" give your product the type of critical accuracy that builds consumer confidence.

MARION "SPECIALS" SOLVE YOUR INSTRUMENT PROBLEM

QUICKLY...

ECONOMICALLY...

ACCURATELY!

Marion "special" instruments incorporate the same high quality of materials and precision workmanship common to the standard line of Marion Meters . . . your assurance special order jobs produced by Marion will give the utmost in satisfaction, service and value.

Write TODAY for complete information.

There's a Marion Meter for You!

You'll find a meter to fit your specific needs in our complete line of electrical indicating instruments. Marion Glass-to-Metal Truly Hermetically Sealed Instruments are a feature of our standard line . . . cost no more than most unsealed meters . . . are 100% guaranteed.

THE NAME "MARION" MEANS THE "MOST" IN METERS

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MARION ELECTRICAL INSTRUMENT COMPANY
Manchester, New Hampshire

HIGH-SPEED RECORDING PROBLEMS SOLVED...

by Photoelectric Recorder..

Further proof that the G-E Photoelectric Recorder can record anything that can be measured is found in the Illinois Testing Laboratory, Inc. Their engineers say, "The G-E Photoelectric Recorder provides a versatile, sensitive recording unit for temperature, light, and electrical phenomena." As shown above they are using it to record very low air velocities measured by their thermo-anemometer, an instrument for air circulation tests.

The extreme sensitivity and high-speed response of the photoelectric recorder make it ideally suited to this application, as well as for thermocouple response tests and resistance thermometry. It gives a complete recorded history of these operations.

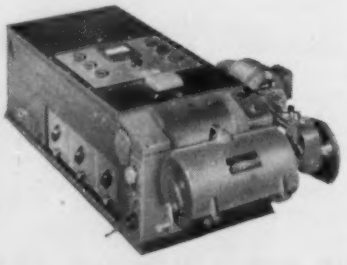
The Illinois Testing Laboratory, Inc. is just one of the many users who have found the G-E Photoelectric Recorder useful in solving their recording problems. There are many other applications embracing the entire field of measurements, since the recorder can *record* anything that can be *measured*.

A wide range of sensitivities (which go as low as 1.0 microamperes for full scale deflection) and response speeds as high as 1/4 second are available in the photoelectric recorder. Basic elements are interchangeable so that one instrument can cover a number of ranges. It is also available as a potentiometer recorder. Write for Bulletin GEA-2394, or contact your nearest G-E sales office and let us help you with your application problems.

PM-10 OSCILLOGRAPH

Increase the scope of your investigations, design, and testing of many types of machines and devices. The General Electric PM-10 Oscillograph provides a permanent record of—

Voltage	Speed	Strain
Current	Pressure	Sound
Time	Stress	Vibrations



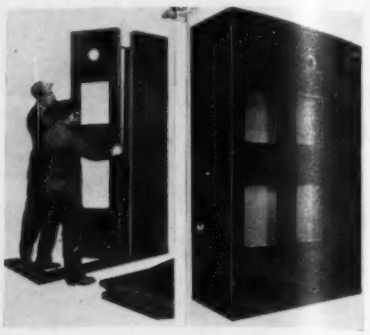
This oscillograph includes simultaneous viewing with recording, which permits traces to be shown continuously on the viewing screen. Wave shapes or deflection can be observed, as well as the arrangement of waves.

Benefit from the extreme sensitivity and versatility of this instrument. Write for Bulletin GEA-3662 today. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

602-118

radiation within 18 mm. of the cap. The intensity was approximately 8000 roentgens per minute at a distance of 18 mm. from the focal spot. . . ."—V. W. Palen, North American Philips Co.



1945. "New type Instrument Control Housing . . . 'Falstrom Knocked-Down Cubicle' made in sections from standard stock parts . . . easy to ship, quick to assemble, interchangeable, and can be added to . . . permits field installations practically overnight . . . a blanket order placed in advance of any contemplated projects can be tapped for shipments immediately when needed. . . . Minimizes intra-plant movement . . . component parts easily moved through doorways, handled in elevators . . . alleviate congestion of lifting and handling devices."—R. E. Hill, Falstrom Co.

1945. "Dew-point Recorder. The company . . . determined to develop instrumentation which would assure that the gases produced were in accordance with dew-point requirements. The relatively slow, tedious and often inaccurate methods used in obtaining the dew points of the constitutent gases . . . belonged in the laboratory, operable successfully only by experienced research personnel . . . development of the 'SC Dew Point Recorder' (and more recently . . . an automatic selector that enables the Recorder to analyze atmospheres from as many as six different sources). In a sense the company was forced into the development of these two devices, because no adequate means had yet been provided to determine dew points rapidly and accurately . . . desirable also to provide a permanent record . . . especially when heat-treating furnaces were of the high production continuous type . . . The uses for the instrument are by no means limited to heat-treating processes alone. . . . The instrument . . . can determine and record dew points within virtually any temperature and humidity range, but is especially applicable when the dew point of a given atmosphere is below 0°F. . . . It automatically purges itself, samples, determines and records the dew point of a gas or gaseous mixture (including air), at intervals of approx. 3 minutes . . . point-by-point record appears practically as a continuous line on the usual 12" 24-hour circular chart. While

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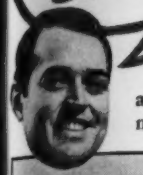
BURGESS SPECIALTY



When battery specifications and performance requirements are most exacting, engineers insist on BURGESS. The wide range of uniform, high quality dry batteries for electronic applications is available only at Burgess, and is the result of over *thirty* years of patient dry battery research by engineering experts.

No. 4FH. Delivers 1½ volts for popular industrial applications.

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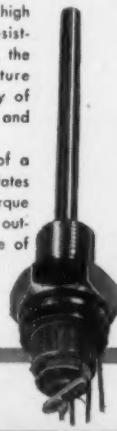
TEMPERATURE TRANSDUCER

from −65° c to +150° c

Latest type Giannini Temperature Transducer combines excellent range, large outputs and high accuracy. Available in resistances up to 20,000 ohms, the new type 4911 Temperature Transducer has a linearity of 1%, an accuracy of 1%, and a sensitivity of 1° C.

The instrument consists of a bi-metallic element that rotates a standard Giannini Microtorque Potentiometer for electrical outputs. This instrument is one of thirty basic Giannini developments in the telemetering field.

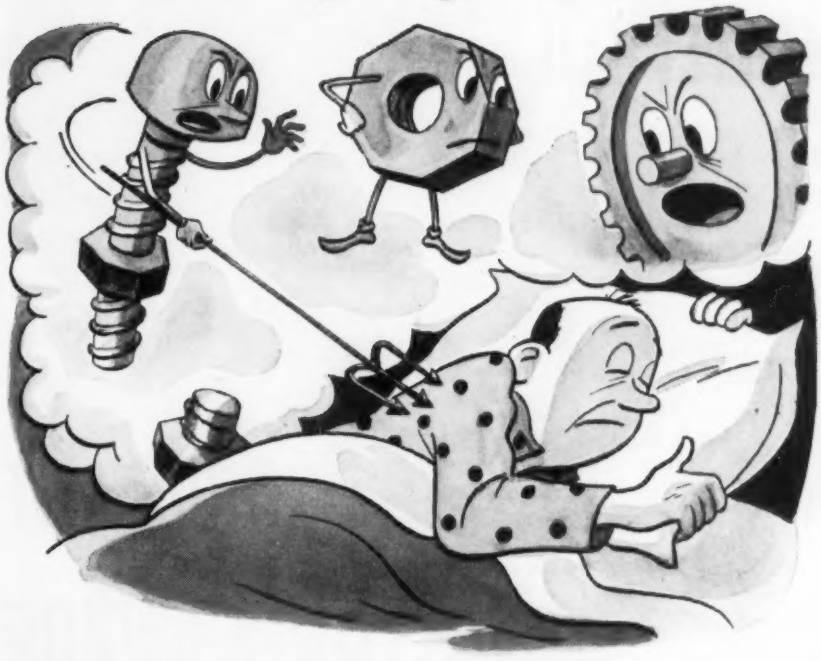


Write for complete engineering details.

G. M. Giannini & CO. INC

REACTION POWER PLANTS • AUTOMATIC FLIGHT EQUIPMENT
185 WEST COLORADO STREET • PASADENA 1, CALIFORNIA

Here's how to harness that "shortage" nightmare



To get supplies and equipment *fast* and lick your shortage problems, specify shipment by Air Express. It's the *fastest possible way* to ship and receive. There's no time wasted at airports because Air Express goes on every flight of the Scheduled Airlines. And you get door-to-door service at no extra cost.

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True case history: Trailer replacement parts are regularly Air Expressed from Kansas City factory. Keeps valuable equipment rolling. Typical shipment: 31-lb. carton picked up 2 P.M. the 11th, delivered Los Angeles, Cal., the 12th, 7 A.M. 1360 miles, Air Express charge only $13.32. Any distance inexpensive, too. Phone your local Air Express Division, Railway Express Agency, for fast shipping action.

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Rates include pick-up and delivery door to door in all principal towns and cities

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PRECISION CONTROL

calls for HAYDON Timing

Combustion safeguard mechanisms require precision, ruggedness and quality construction in every component . . . that's why Wheelco Instruments Company chose Haydon timing for their extremely dependable Model 1131A Flame-otrol. This Wheelco safety device not only shuts off both main and pilot valves immediately on flame failure, but also provides a time delay for purging the chamber of combustible gases before relighting can be attempted . . . Haydon's #1600 series motor provides the accurate timing element.

Haydon motors are widely used in many combustion control devices such as day-and-night thermostats; stoker controls, oil burner controls, safety devices, etc. There is a Haydon unit to meet every timing requirement . . . 9 different motor series, hundreds of speeds from 450 rpm to 1 revolution per 1000 hours . . . variations to fit your specifications.

Typical of constant engineering advances is a new Haydon slow speed motor, soon to be available for 1 revolution per 12 hours, 1 day and 1 week . . . inexpensive timing for thermostats, switches and control equipment.

Take advantage of Haydon timing experience; have a representative call. Write for the new Haydon Engineering Data Catalog.

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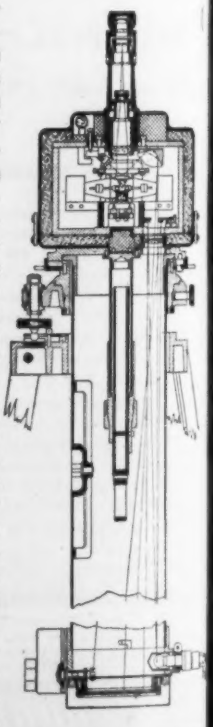
HARNESS TIME TO YOUR PRODUCTS

SUBSIDIARY OF GENERAL TIME INSTRUMENTS CORPORATION

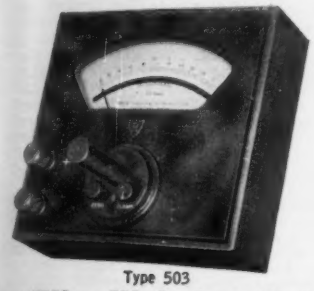
the basic principle of operation is the same as that of the laboratory dew-point cup, the actual instrument constitutes an 11-tube electronic amplifying circuit, complete 'Freon 12' refrigeration unit, electronic cycle timing unit, etc. Operation of the recorder is independent of the composition of the atmosphere. The presence of 'impurities' such as H_2S and SO_2 has no effect on its accuracy. Nor does the presence of condensable hydrocarbons which . . . ordinarily would cloud the reflecting surface . . . It is in the attainment of this feature that many months of development were devoted." —Ralph Hanna, Research Engineer, Surface Combustion Corp.

1945. "Branson Instruments, Inc., organized for developing and manufacturing special instruments. . . . first project . . . instrument for non-destructive thickness testing of tanks, pipes, and pressure vessels. Inspection methods in use at that time had hardly been changed in several decades. . . . Capacity operation of refineries and chemical plants increased the need for a rapid and reliable inspection method. . . . The supersonic resonance method was found to be suitable, . . . audible indications for speed and ease of operation. . . . the 'Audigage' Thickness Detector satisfied these requirements, . . . is already used by refineries with more than ⅓ of the total US cracking capacity. . . ."—P. K. Block, Branson Instruments, Inc.



1945. "Magnetic Surveying Instruments. (These are selected as outstanding; we produce many other instruments.) Before the war, for geophysical exploration work such instruments were imported . . . particularly true of the Schmidt type Magnetometer of Magnetic Field Balance . . . had been used by geophysical, oil and mining companies for many years . . . The Ruska Instrument Corp. has had many years of experience in repairing, servicing and calibrating these instruments . . . decided in 1945 to design and produce a group of American-made magnetometers . . . In designing them an effort was made to overcome some of the operating

RAWSON
SEMI-SUSPENDED METERS



Type 503

for Ultra-High Sensitivity

0.5 Microampere Full-Scale (7000 ohms)
0.24 Millivolt Full-Scale (10 ohms)
High Resistance Voltmeters (Megohm per Volt). Many other ranges.

Accurate Portable Meters need no leveling. Will often replace light-beam galvanometers or vacuum tube voltmeters.

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Special apparatus built to order

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Unique construction enables operator to rapidly determine temperature even on minute spots, fast moving objects, or smallest stream; no correction charts, no accessories, no maintenance expense. Special "FOUNDRY TYPE" and "Universal TRIPLE RANGE" have, in addition to standard calibrated range, a red correction scale determining TRUE SPOUT and POURING TEMPERATURES of molten iron and steel when measured in the open.

Stock ranges 1400° F. to 4000° F.
Bulletins on PYRO Optical, Radiation, Surface and Immersion Pyrometers on request.

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RF CAPACITOMETER

TYPE YCL-1

For Quick, Accurate Measurement of Capacitance and Inductance

PERMITTING measurements directly at radio frequency of a wide range of capacitance and inductance, the YCL-1 is a most valuable equipment for production, research and industrial laboratories.

Simple in design and self-contained, it can be operated by non-technical personnel. The YCL-1 is a compact and efficient unit which provides accuracy without the use of bridges usually employed for these measurements.

To improve stability of operation, the internal measurement circuits are operated from a built-in electronically regulated power supply.

This General Electric Capacitometer is suitable for portable use, or it may be removed from the cabinet and mounted in a standard nineteen (19) inch relay rack.

CAPACITANCE:	0 to 20,000 micromicrofarads
ACCURACY:	± 1 micromicrofarad or 0.1%, whichever is larger
INDUCTANCE:	0 to 10,000 microhenries
ACCURACY:	± 1 microhenry or 0.1% whichever is larger

For complete information on the YCL-1 Capacitometer and other precision equipments write: *General Electric Company, Electronics Department, Electronics Park, Syracuse, New York.*

GENERAL ELECTRIC
165-62

Ingenious New Technical Methods

To Help You Simplify Production

New Tool Inserts Rubber Grommets Quickly . . . Easily!

A new tool called a Grommet Inserter is shown above inserting a rubber grommet in a Sub-Chassis of a Zenith 7H820 Table Model Radio. The inset illustrates a close up view of the Grommet Inserter before and after the grommet has been inserted.

Anyone can insert grommets in an instant with the new Grommet Inserter. Saves time, labor, and assures perfect fit. No longer is it necessary to use the time-consuming, cumbersome method of insertion by hand. The new Grommet Inserter does it efficiently.

Simple as A-B-C. All you do is push the Grommet Inserter through the hole, open jaws, place grommet in jaws, and pull back—leaving grommet firmly in place, and perfectly fitted. Comes in four standard sizes: 1/4", 5/16", 3/8", 7/16". Can be furnished in any special sizes to order.

You can count on chewing gum, too, to help step up employee's on-the-job efficiency. Chewing gum helps relieve tension and thereby enables him to work quicker and easier while leaving hands free. That's why more and more plant owners are making Wrigley's Spearmint Gum available to everyone.

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AC-60

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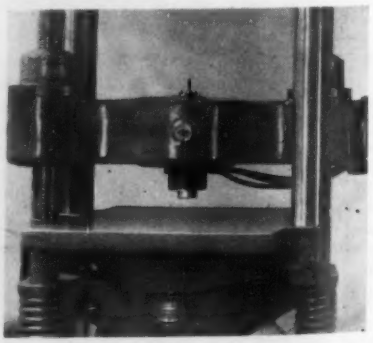
difficulties of the older instruments. While Ruska field instruments are a great mechanical improvement over former types of magnetometers, two new recording base station magnetometers have been developed . . . Maintenance and servicing of former types has been extremely difficult and could be done only by highly skilled instrument mechanics. An instrument was developed which remains accurate for longer periods of time and which permits the operator to make most of the necessary adjustments rapidly in the field. . . . The Ruska Recording Magnetometer (illustrated) records time, temperature and diurnal variations in such a way that this information can be readily correlated; nevertheless, the field operator can take visual readings on his base instrument at any time . . . without disturbing the photographic recording. Thus, one operator can do the work for which two were previously required. . . . does not require a portable dark room or light-tight tent. For the first time it is possible for the field operator to obtain complete information concerning the phenomena which influence his field observations without employing an additional helper or heavy equipment. . . . Ruska Magnetometers have a standard sensitivity of 10 gamma per scale division. Recording instruments . . . recording sensitivity of 10 gamma per millimeter. The Company has its own magnetic field station where instruments are being adjusted for all parts of the world. . . . instruments . . . in use in every continent."—Walter Ruska, Ruska Instrument Corp.

1945. "These same automobile companies [see 1940] were interested in the 'Remotomike' . . . measuring engine bores. 'Remotomike' was again modified into a multiple unit . . . continuously measuring eight cylinder bore diameters at once giving maximum and minimum readings to within fifty millionths of an inch. . . . Automatically stamping actual diameters on the blocks so that pistons can be matched to cylinders. . . ."—F. M. Poole, Poole Instruments, Inc.



1945. "The 'Tate-Emery Air Cell' . . . extending large-capacity testing machines into much lower ranges, obviating the necessity for owning special

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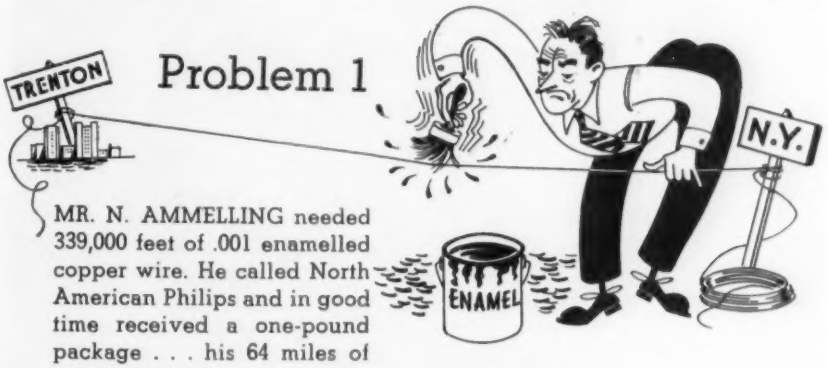
What's your Problem?

Fine Wire? Tungsten? Molybdenum?

Problem 1



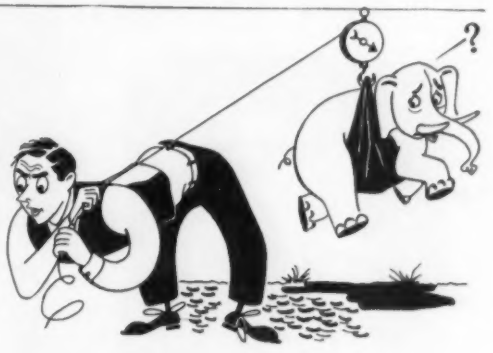
MR. N. AMMELLING needed 339,000 feet of .001 enamelled copper wire. He called North American Philips and in good time received a one-pound package . . . his 64 miles of wire enamelled to his specifications.

Problem 2

MR. N. O. EMISSION, II, required plated grid wires. He solved his problem with a call to Fine Wire Headquarters. We shipped him some gold plated tungsten and molybdenum wires. Result: no secondary emission.

Problem 3

MR. E. LONG GATE wanted a quantity of Fine Wire to meet close specifications for tensile strength and elongation. Calling Fine Wire Headquarters, he soon received the order, filled to his exact specifications.



the answer

WHY not call Fine Wire Headquarters when you have a question about fine wire? We can't do the impossible, but we can do lots of things that can bring you the right fine wire for the job. So—when you have a problem on Fine Wire, Tungsten or Molybdenum—wire, phone or write to North American Philips, makers of NORELCO Fine Wires, and ELMET Tungsten and Molybdenum products.

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- NON-MAGNETIC
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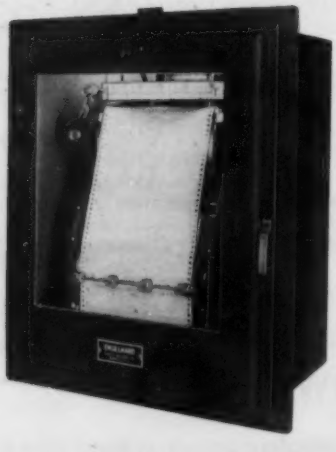
PERMO INCORPORATED CHICAGO 26

MANUFACTURING METALLURGISTS

Engelhard Recorders



This is the new flush mounting case for the well known Engelhard Direct Deflection Indicator-Recorder. It was shown for the first time at the recent Chemical Show in New York and received wide approval.

It is now possible to use this instrument on panel type construction control boards, and be harmonious in looks with other necessary units.

The outside is finished in fine grain black wrinkle, and the interior is illuminated by means of a fluorescent light. Construction is reinforced steel.

Bulletin #800 for CO_2
Bulletin #400 for Pyrometry

CHARLES ENGELHARD, INC.
900 Passaic Ave. East Newark, N. J.

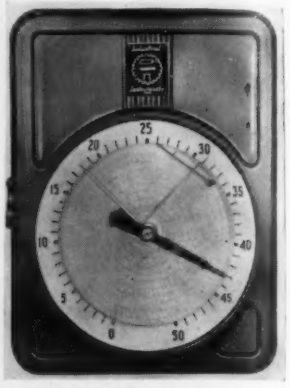
DIFFERENTIAL PRESSURE INDICATOR MODEL 181

- 6" HIGH VISIBILITY DIAL
- RANGES 0-50 INCHES OF WATER UP TO 0-200 P.S.I.
- PRESSURE RATINGS UP TO 3000 P.S.I.
- UNIVERSAL MOUNTING
- RUPTURE-PROOF BELLOWS UNIT

Write for Bulletin 181-1

BARTON INSTRUMENT COMPANY
3500 UNION PACIFIC AVE
LOS ANGELES 23 CALIF

small testing machines . . . sizes of 0-3 to 0-1200 lbs. for insertion into th movable crosshead of Testing Machine Deflection is approx. 0.0002" at fu load. It is essentially a pneumati force-balance or transmitter having a output proportional to the load. Th output pressure is fed either to Bour don gage type indicators or to a Tate Emery load indicator. Load ranges ar independent of the capacity of the tes ing machine . . ."—M. G. Van Voorhi for Baldwin Locomotive Works.



1945. "The Electrolytic Conductivit Recorder . . . progress in electrolyti conductivity instrumentation [see 1940 was climaxed in the recorder type . . incorporated an a-c. bridge circuit an operated on the null balance principle . . furnished for 1, 2, 3 or 4 continuous lin records on the same 12" chart. A separat amplifier and motor-driven slidewire wa used for each recording pen—no need fo switching devices. All pens of a multipl pen recorder may move at any time o simultaneously as required. Alternatively records of both conductance and tempera ture may be made on a single chart. A wid choice of conductivity cells . . ."—A. C Lescaboura, for Industrial Instruments, In

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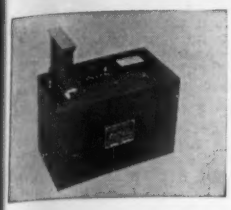

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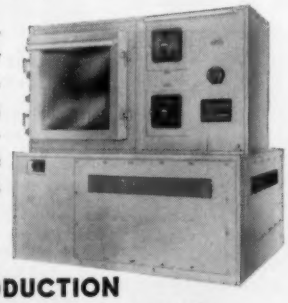

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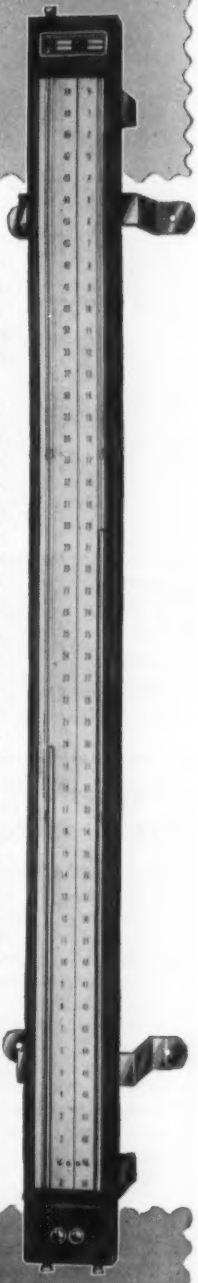

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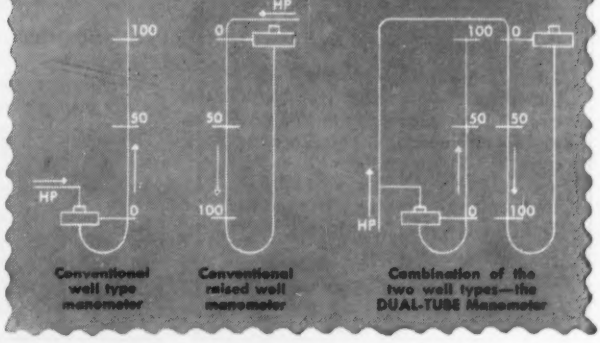

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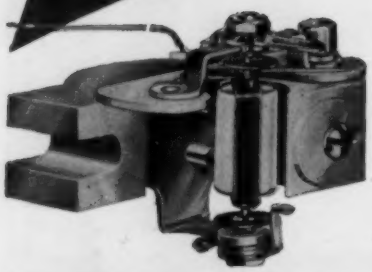

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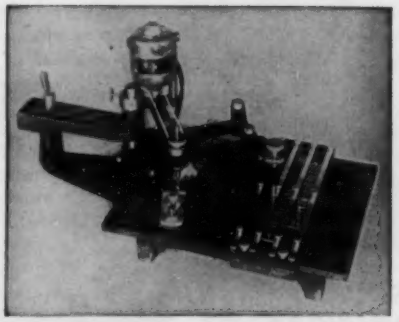

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filed Dec. 6, 1930), "Electrical Translating Apparatus." Discloses a three-core transductor for automatic train control with two control circuits.

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(71) Alan S. FitzGerald, U. S. Patent 1,914,201, issued June 13, 1933, application filed Oct. 2, 1930), "Electric Control System." Uses transductor as a phase shifting device.

(72) Andrew J. Sorenson and Philip H. Dowling, U. S. Patent 1,914,220 issued June 13, 1933 (application filed June 23, 1930), "Electrical Translating Apparatus." Two transductors are used to operate a differential relay for automatic train control.

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(74) Boris V. Nagashev, U. S. Patent 1,920,803, issued Aug. 1, 1933 (application filed Oct. 11, 1930), "Control System for Alternating Current Motors." Transductor is used to control the motor which feeds a welding electrode.

(75) August Schmidt, U. S. Patent 1,921,703, issued Aug. 8, 1933 (application filed Nov. 13, 1931), "Variable Reactance

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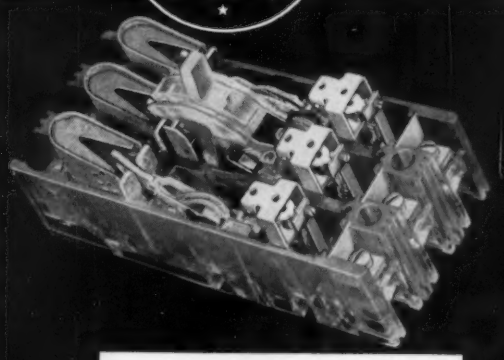

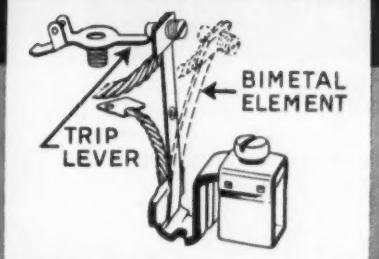

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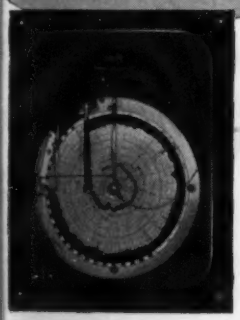

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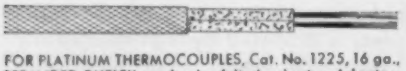

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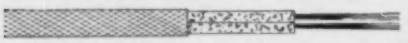

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Device," Discloses a form of transductor in which the saturation curve is discontinuous.

(76) Alan S. FitzGerald, U. S. Patent 1,929,059, issued Oct. 3, 1933 (application filed Dec. 17, 1931), "Electric Fault Responsive Apparatus."

(77) Chauncey G. Suits, U. S. Patent 1,940,335, issued Dec. 19, 1933 (application filed Mar. 25, 1932), "Electrical Time Delay Apparatus."

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(80) T. M. Austin and F. W. Cooper, "Two Applications of Non-linear Circuits," *El. Eng.*, Vol. 53, Feb. 1934, pages 293-300.

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(83) Alan S. FitzGerald, U. S. Patent 1,948,372, issued Feb. 20, 1934 (application filed Sept. 2, 1931), "Regulating System."

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(87) Frank G. Logan, U. S. Patent 1,977,193, issued Oct. 16, 1934 (application filed June 14, 1932), "Electric Controlling Apparatus." Discloses that the output of a transductor may be controlled by phase shift procedures.

(88) Alan S. FitzGerald, U. S. Patent 1,980,395, issued Nov. 13, 1934 (application filed Oct. 3, 1931), "Electroresponsive System."

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(92) V. D. Gussakov, "Induction of D-c. Saturable Reactors" (in Russian), *Elektrichestvo*. Oct. 1935, pages 47-50.

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(94) M. J. Brown, "Design of Saturable Reactors," *Radio News*, Vol. 16, March 1935, pages 540-541.

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(97) Alan S. FitzGerald, U. S. Patent 1,988,271, issued Jan. 15, 1935 (application filed Jan. 10, 1931), "Electric Valve Circuit."

(98) Chauncy G. Suits, U. S. Patent 1,989,500, issued Jan. 29, 1935 (application filed Sept. 17, 1930), "Electric Translating Circuit." A saturable reactor is employed with a vacuum tube for intermittent operation of lamps.

(99) Frank G. Logan, U. S. Patent 1,997,179, issued April 9, 1935 (application filed May 7, 1931), "Electric Controlling Apparatus." Discloses a numbe[r] of uniq[ue] transductor control circuits ba[sed] on th[e] fact that if a regulated rectifier is used [to] energize the control circuit of a transduc[tor], and if reactances are inserted betwe[en] the counterphase terminals of the pow[er] transformer and the rectifier anodes, th[e] voltage output may be controlled from ze[ro] to the maximum by adjustment of a resi[st]ance and/or a capacitance shunted be[t]ween the rectifier anodes.

(100) Frank G. Logan, U. S. Pate[nt] 2,003,945, issued June 4, 1935 (applicati[on] filed Sept. 5, 1931), "Electric Controlli[ng] Apparatus." Discloses additional circui[ts] similar to reference (99).

(101) Chauncy G. Suits, U. S. Pate[nt] 2,006,970, issued July 2, 1935 (applicati[on] filed Sept. 23, 1933) "Control of Consta[nt] Current Circuits." A saturable reactor [is] used to provide shunt loading of a consta[nt] current system.

(102) Alan S. FitzGerald, U. S. Pate[nt] 2,021,099, issued Nov. 12, 1935 (applicati[on] filed July 27, 1933), "Electric Control Sy[s]tem." Selective control system which re[-] quires only two conductors between tran[s]mitter and receiver.

(103) Alan S. FitzGerald, U. S. Pate[nt] 2,026,124, issued Dec. 1, 1933 (applicati[on] filed Dec. 1, 1933), "Automatic Regulati[ng] System." Transformer taps are changed t[o] transductors (without moving parts).

(104) G. W. Drake, "Angle Switching [of] Synchronous Motors," *El. Jl.*, Vol. 33, M[ar.] 1936, page 213.

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(106) Harold Pender and Wm. A. De[l] Mar, "Action of D.C. Mmf. with A.C. Mmf.," *Electrical Engineering Handbook* (Pender) Vol. 1, 1936, pages 4-20.

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(108) C. W. Drake, "Saturable Reacto[r] Starters for Synchronous Motors," *El. J[l.]* Vol. 33, 1936, pages 178-180.

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(110) Alan S. Fitzgerald, U. S. Pate[nt] 2,027,311, issued Jan. 7, 1936 (applicati[on] filed June 21, 1933), "Magnetic Amplifier[s]."

(111) Alan S. FitzGerald, U. S. Pate[nt] 2,027,312, issued Jan. 7, 1936 (applicati[on] filed July 23, 1934), "Magnetic Amplifyi[ng] and Control System." Magnetic amplifi[ers] with polarization and latch-in characteri[s]tics.

(112) Frank G. Logan, U. S. Pate[nt] 2,036,708, issued Apr. 7, 1936 (applicati[on] filed Aug. 8, 1932), "Electric Controlli[ng] Apparatus." This is an important varie[ty] of the type of control circuit disclosed [in] reference (99).

(113) Carroll Stansbury, U. S. Pate[nt] Re. 18,853, reissued Feb. 11, 1936 (applic[a]tion filed May 24, 1934 for original U. S. Patent 2,013,221), "Motor Controller." Em[-] ploys vacuum tubes and transductor [to] hold constant speed.

(114) Frank G. Logan, U. S. Pate[nt] 2,040,492, issued May 12, 1936 (applicati[on] filed May 31, 1933), "Rectifier Regulator." Employs the scheme shown in reference[s] (99) and (112) to obtain the desired vol[t]age-load relationship from a rectifier pow[er] supply, be it increasing or decreasing vo[l]

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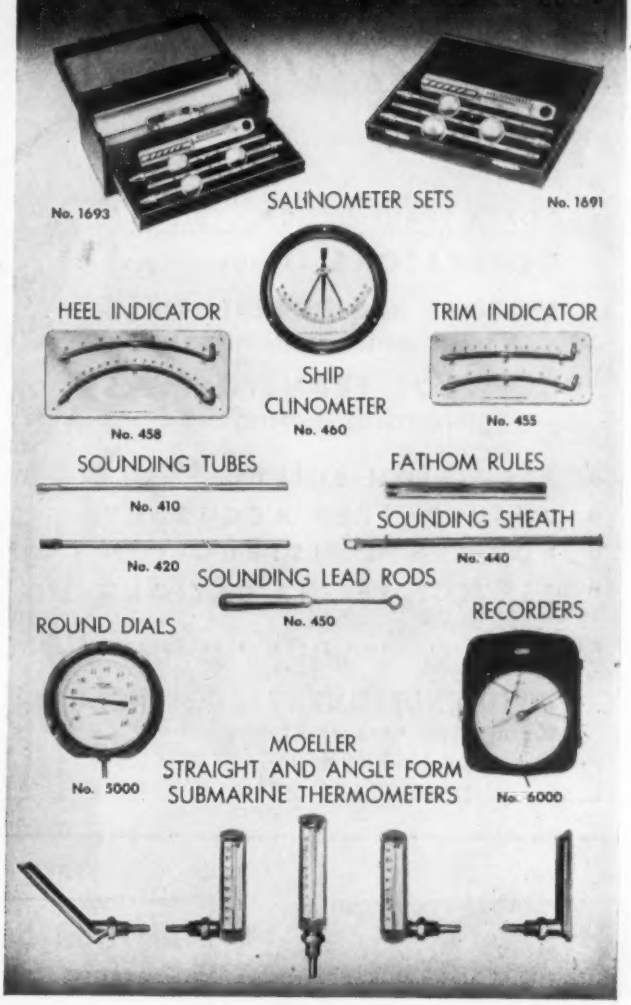

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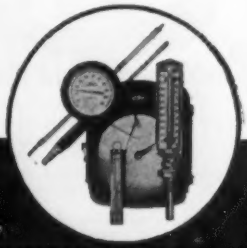

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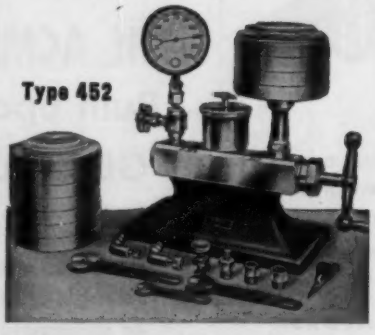

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(115) Frank G. Logan, U. S. Patent 2,047,915, issued July 14, 1936 (application filed Sept. 17, 1931). "Electric Controlling Apparatus." Transductor circuit which allows the use of a smaller core and has greater range of adjustment of voltage by use of a booster transformer and a bucking transformer.

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(129) Frank G. Logan, U. S. Patent 2,074,552, issued Mar. 23, 1937 (application filed May 20, 1933), "Voltage Regulator." This is a variation from reference (114).

(130) Alan S. Fitzgerald, U. S. Patent 2,074,835, issued Mar. 23, 1937 (application filed Dec. 5, 1933), "Electric Elevator Indicating System."

(131) Frank G. Logan, U. S. Patent 2,078,880, issued Apr. 27, 1937 (application filed Feb. 9, 1935), "Electric Controlling Apparatus." Discloses transductor circuits for illumination control in which the calibration of the control remains accurate even when the quantities of lamps are varied.

(132) Ralph D. Amsden, U. S. Patent 2,082,607, issued June 1, 1937 (application filed May 27, 1936), "Electrical Control System." Discloses the use of the transductor-controlled rectifier which is used with a storage battery to obtain a full-floating d-c. power supply which is completely automatic.

(133) Frank G. Logan, U. S. Patent 2,092,319, issued Sept. 7, 1937 (application filed Dec. 20, 1934), "Electric Controlling Apparatus." A regulated rectifier system to supply a multiplicity of loads from a single source such as a transformer.

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(135) William R. Perry, U. S. Patent 2,102,911, issued Dec. 21, 1937 (application filed Feb. 10, 1934), "Motor Control System."

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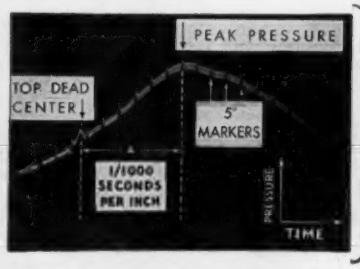

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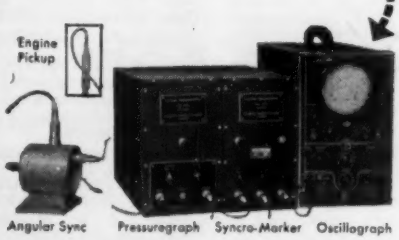

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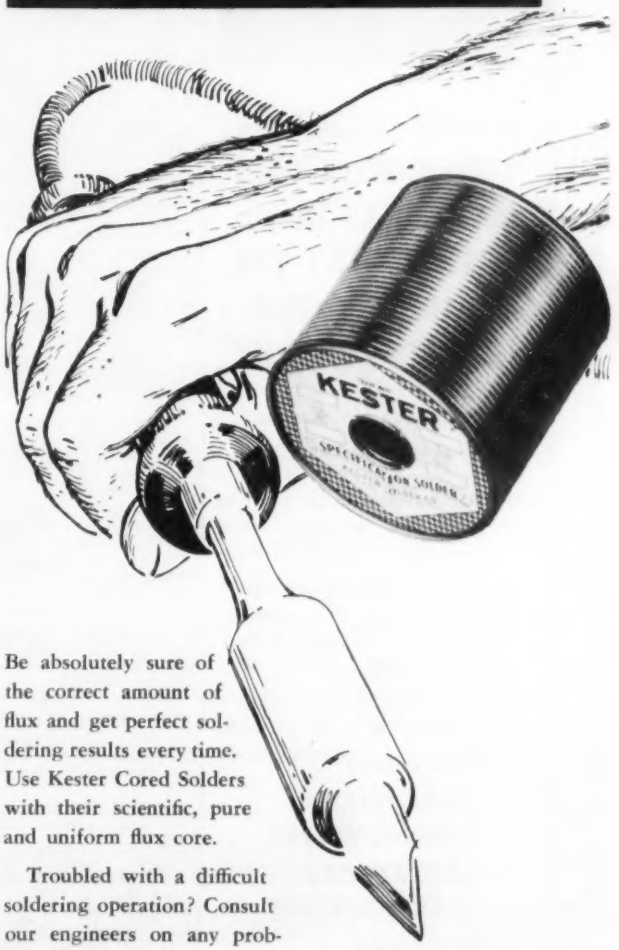

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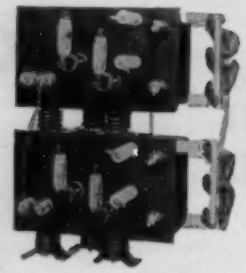

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JOURNAL of the Instrument Society of America

Editor, R. R. PROCTOR, 2213 Ridge Ave., Evanston, Ill.
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Editorial

"WHY BELONG TO THE I.S.A.?"

This editorial is a preliminary attempt to bring to the members some insight into Society operations and to answer the occasional criticisms written in to the officers. It is inspired by a letter recently received which was entitled, "This Could Be an Editorial," and reads:

"Considerable interest prevails concerning the Semiannual ISA Conference . . in New York the latter part of January. It also poses the question—why are the registration fees the same for both members and non-members? Or, the more pertinent question—why be a member of ISA when you can receive the JOURNAL in 'INSTRUMENTS' for $2.00 per year on a three year basis, attend all Section meetings free, and attend shows and conferences by paying the same registration fee as a member?

"What are we trying to do—discourage membership? It certainly appears that consideration should be given to Mr. Average Member who doesn't aspire to become an officer of the Society, either locally or nationally, *which is a member benefit.* It's obvious that Mr. Average Member is not getting the economic break he deserves.

"One way of at least partially rectifying this injustice is to increase, by several hundred percent, the non-members' registration fee at all ISA Conferences . . .

"(Signed) *R. E. Hadady.*"

This letter resembles others in that it implies that the member should receive tangible returns upon which he can place a dollar value to be balanced against his dues. How can this attitude be reconciled with the stated objectives of the Society: "To advance the arts and sciences connected with the theory, design, manufacture and use of instruments in the various sciences and technologies"? Certainly, advancing a man's chosen field of endeavor can be of estimable value to him even though there is no place to hang a price tag.

The methods used by the Society in accomplishing its objectives are: (1) Providing meeting places where the latest instrumentation techniques and developments may be made public—(2) Providing an opportunity for the individual to increase his knowledge through educational activities—(3) Building up a literature of Recommended Practices in instrumentation—(4) Providing a meeting ground for the instrument industry and the user, and (5) Bringing to the lay public and executives a realization of the importance of the instrument man and his work. It is in keeping with the American tradition that the Society was organized by a group of individuals who saw the need and were willing to pitch in and get things going without waiting for someone else to do it. They realized that their efforts would help member and non-member alike, but they saw that a closed organization working solely for the benefit of a small number would defeat its own purpose.

If the Society is doing its job, it will be continually strengthened by addition of new members, who, as they sense its value and realize its objectives, can be reached quickly by the concerted support of the greatest number of instrument men.

In regard to registration fees, it has been the policy to charge the minimum amount which will defray the expenses of the local Section acting as host. It would be preferable to have no registration fee in order to encourage the widest possible attendance. A successful meeting is a whale of a good advertisement for the Society and the more members attending the more potential members we reach.

The Annual Meeting and Exhibit is a joint activity of the Society and the instrument industry. It is to the advantage of members to have the greatest number of manufacturers represented, and this can be achieved by the registration of the greatest number of instrument men. It is simply not good business to charge registration fees at these affairs.

In two short years the Exhibit has become the *national medium for the instrument industry to show its products* to the instrument buyers and users. The publicity attending these meetings has brought to the attention of executives and laymen alike the vital importance of instrumentation. *Every ISA member can feel proud that his membership has contributed directly to the success of these meetings,* which would have been impossible without the existence of the organization.

It is true that a non-member will derive benefit from the activities of the I.S.A. as well as will the members. It needs little argument, however, to show that concerted action by the greatest number will have the greatest effect on whatever is desired or attempted in guarding the welfare or improving the status of the instrument man. Many of the objectives of the Society can be achieved by passive membership, i.e., showing by the payment of dues that the member is in accord with these objectives and is helping make a national organization possible with sufficient funds to work in his interest.

Probably the greatest benefits an individual member can obtain will be found in participation in I.S.A. activities, either local or national, or both. A member's dues purchases this right to participate. The time and effort expended is returned many times over through friendships formed with outstanding instrument men and with the Joe Doakes of the plants—there are none with whom the exchange of ideas cannot be beneficial. Among the rewards are technical information which would not have been otherwise available, and a deep sense of satisfaction in personal development.

For those who, as Mr. Hadady suggests, don't desire to collect the membership benefit which can be obtained by becoming an officer or committee worker in some phase of I.S.A. activity, the foregoing discussion may be on the idealistic side. These men want to know what *tangible* returns they are receiving for their money.

H. L. Hildenbrand, New *Journal* Editor

Effective April 1, 1948, Mr. H. L. Hildenbrand of Onarga, Illinois, is the new Editor of the JOURNAL. Henceforth all material intended for publication in the JOURNAL, and all correspondence pertaining to JOURNAL affairs, should be sent to Mr. Hildenbrand, Box 35, Onarga, Illinois.

"Hildy," who has just retired from business life on a large scale to settle in his home town of Onarga, was the 1947 President and Director of the New York Section. His retirement as the New York representative of Esterline-Angus Company was forecast in the November, 1947, issue of the JOURNAL, in which issue he was the subject of a "Who's Who" write-up.

Editor Hildenbrand brings to the JOURNAL many years of experience in technical writing and editorial work. He has been in years past the Engineering editor of *Electrical Record,* Engineering Editor of *Electrical Manufacturing,* Managing Editor of *Electrical Manufacturing,* and Assistant Editor (and later Circulation Manager) of Westinghouse's *The Electric Journal.*

On behalf of the present JOURNAL staff, we wish Hildy the best of luck in his new role.

—RRP

It should be pointed out first of all that one-half of the dues of each member is returned to the local Section of which he is a member, while the remainder is for the operation of the national organization. With the present membership, an adequate working force could not be supported by this income. The revenue obtained from the annual exhibit supplements this and makes possible the operation of the national office.

A glance at the latest Treasurer's report covering 1947 shows the following:

	Receipts	*Disbursements*
Membership Activities	$21,810.65	$20,081.50
Meeting Activities....	4,470.62	12,626.21
Exhibit Activities ...	34,065.00	15,460.75
Headqtr's Operations	50.60	8,030.06
Society Operations ..	935.01	2,811.24
Totals	$61,331.88	$59,009.77

Of the first item, Membership Activities, the amount actually received from dues was $21,654.90, and the refunds to the Sections on these dues amounted to $9,756.36. The direct return to the members included $5,360.00 for the recently issued ISA Recommended Practices Binders and the reference material supplied therewith, $2,875.00 for subscriptions to "Instruments", including the I.S.A. JOURNAL, and $2,267.80 for the I.S.A. PROCEEDINGS (a meeting activity). It is thus seen that of the $21,654.90 received from dues, practically all ($20,259.16) went directly back to the Sections and members.

Through the efforts of a few experienced members of the Society, the exhibit has been able to supply the balance of the funds for Headquarters operations. By the application of good business practices the Society is in a sound financial condition. There are many things that could be done (and will eventually be done) for increasing the services to members if more money were available, but the officers have preferred to build slowly and retain a strong position as the membership develops.

As the Recommended Practices Committee projects develop, more material for insertion in the Binder will be made available—*to members*. When enough money is available, more projects will be undertaken by the Publications Committee—to be made available *to members*. The *tangibles* will increase, but it takes time and money to promote such activities. Even passive membership by the "Mr. Average Member" of Mr. Hadady's letter will insure that these aims will be accomplished before long.

The intangible benefits which can be derived from membership will also increase proportionately, and after all, the strongest case can be made for the Society in these intangible benefits. If the dissatisfied, hesitant, or questioning members and prospective members could be somehow imbued with half the spirit and enthusiasm of those who are working with and for the I.S.A. and reaping the intangible benefits (leading toward their ultimate *tangible* betterment), we are sure there would be no more complaints. The I.S.A. is a "natural" and membership will eventually be a "must"—so why not now?

—R. R. PROCTOR

Editor's Notes

1. MORE SECTION APPLICATIONS

Rochester's affiliation with the I. S. A. was announced in last month's issue. Since that time two more groups have petitioned for charters—Houston (Texas), and Central Illinois (Peoria). These applications are, at this writing awaiting Executive Committee action. With the issuance of these charters, the I. S. A. will be 39 Sections strong.

NOTE: Since the above news was written, Central Illinois and Houston have been granted charters.

2. GALLAGHER PAPER POPULAR

In February, 1947, Mr. Glen G. Gallagher, Universal Oil Products Company, Chicago, presented a short paper on "Control of Narrow-boiling-range Fractionating Columns" before the Chicago Section of the I. S. A., of which Section he is a member. This paper, dealing with a novel system of tower control which is in effect, on a binary column, a composition controller, was (and has since been) very well received. It was published in *Instruments* in November, 1947 (page 1004), was then published in *The Oil & Gas Journal* (Feb. 5, 1948), and has just appeared in the March issue of *The Petroleum Refiner*.

This article is recommended reading matter for anyone interested in very close control of fractionating equipment. We mention it here because we feel that any paper by an I. S. A. member which obtains that much publicity on its own merits deserves honorable mention—at least to the extent of calling it to the attention of I. S. A. members.

This is, of course, not the only paper which has achieved this sort of success. We have not mentioned others previously only because we have not known about them. However, we will at any time be proud to recognize the ISA speakers and their papers by giving them honorable mention in these columns if the information is made available to us.

(Just as this goes to press, we learn that Mr. Gallagher has taken a position with the Flour Corporation, and will have left for California by the time this is in print. His place with U.O.P. will be taken by H. A. Huisberg, who has been Instrument Engineer at Universal's Riverside plant for several years.)

3. THANKS FROM YE EDITOR

This is the last issue of the JOURNAL to be gotten out by its present Editor. As announced elsewhere in this issue, this work is to be taken over by H. L. Hildenbrand, former President and Director of the New York Section.

We would like to take this opportunity to thank all of those with whom we have had the pleasure of working in preparing the JOURNAL for its readers each month, with particular thanks to the various Section Secretaries and JOURNAL Correspondents who have kept us supplied with news and other material. We have worked diligently to build up the present JOURNAL "staff" and we hope Mr. Hildenbrand will find it as cooperative as we have.

As our final word in these columns, we will make our exit on a more personal plane by an open letter to all readers—quoted from a general letter sent to all Section Secretaries and JOURNAL Correspondents in March:

" . . . I have enjoyed my work with you and with the JOURNAL, and am proud to have been its first Editor. It has taken considerable work to bring it through its first year and a half of existence. It has grown, however, and is now ready for further development under more experienced guidance. . . .

"I am confident that the JOURNAL will grow as you would like to see it grow, and that it will become more and more useful to all I.S.A. members under Mr. Hildenbrand's guidance. Your future cooperation with the new Editor will be greatly appreciated.

"In retiring from the Editorship because of the press of other duties, I can only say that I greatly appreciate your past cooperation with me in our mutual efforts and desires to make the JOURNAL a useful publication. I have acceded to President Exline's request that I continue to serve on the Publications Committee of the Society, and it is my intention to remain active in Society activities for some time to come. It is my hope, therefore, that I can continue to maintain the many friendships I have established while acting as your Editor.

Sincerely yours,

"(signed) *R. R. Proctor.*"

Official News

TO ALL SECTION SECRETARIES

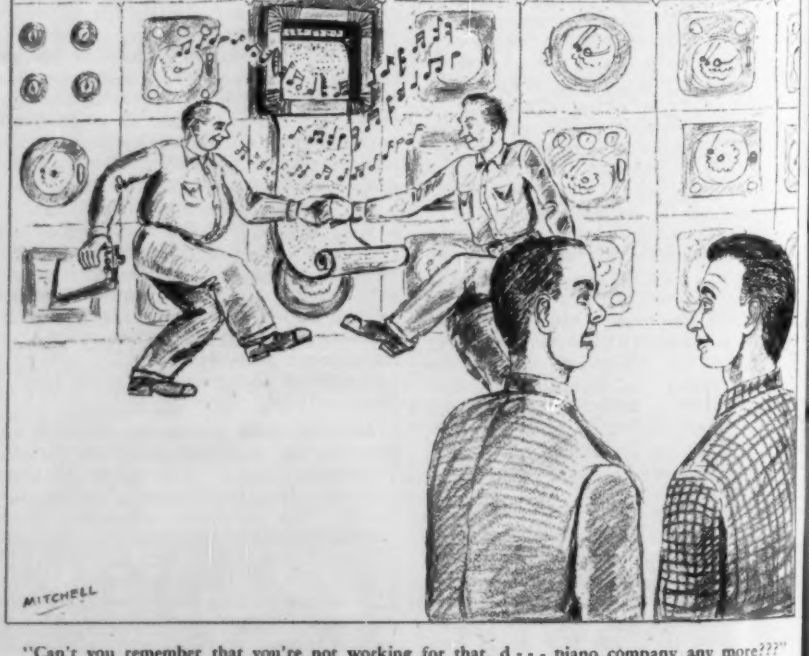
Following are this month's changes and additions to be incorporated in the general list of Section Secretaries, Directors and JOURNAL Correspondents which was published in the December (1947) issue of the JOURNAL:

CENTRAL INDIANA: New JOURNAL Correspondent—E. E. Taylor, 220 No. Gray St., Indianapolis, Ind.

NEW YORK: New JOURNAL Correspondent—E. B. Schofield, Sperry Gyroscope Co. Great Neck, Long Island, N. Y.

PHILADELPHIA: New Director—John Johnston, Jr., 2 Crestwood Place, Hillcrest, Wilmington, Del.

RICHLAND: Preferred addresses of (1) Secretary—B. E. Woodward, 1330 Marshall St., Richland, Wash., and (2) JOURNAL Correspondent—J. K. Flickinger, Dorm. M-2, Richland, Wash.



"Can't you remember that you're not working for that, d - - - piano company any more???"

CALENDAR OF EVENTS

Section	Date of Next Meeting	Type	Place	Speaker	Subject
Central Indiana	5/4/48	MX	Purdue Ext. Center, Indianapolis	Mr. Witt, Sheffield Co.	"Modern Concept of Gaging"
Charleston	5/3/48	DX8	Kanawha Hotel	Dr. D. J. Bergman, U. O. P. Co.	"Fluid Catalyst Plants"
Chicago	5/7/48	DX-	Furniture Club of America	Installation of New Officers	Social Program—Ladies Night. Entertainment, Dancing, Etc.
Cleveland	5/26/48	DX8	Cleveland Eng. Soc.	John R. Green	"Instrumentation and Control in the Steel Industry"
Cumberland	4/27/48	DX8	Algonquin Hotel	Albert F. Sperry, Panellit, Inc.	"Automatic Regulation on Centralized Control"
Eastern New York	5/4/48	-	Siena College, Loudenville	F. H. Trapnell, E. I. Dupont Co.	"Instrumentation and Plant Design . . . "
Gulf Coast	4/20/48	MX	Lamar College, Beaumont	R. E. Price, Gulf Oil Co.	"The Mass Spectrophotometer"
Kansas City	4/27/48	MX	U. S. Engrs. Lab., Corps of Engrs.	District Engineer	Tour of Laboratory and Demonstration of Test Instruments and Techniques
Louisville	5/25/48	M8	Calvert Hall, Seagram's	C. B. Moore, Moore Products Co.	"Solution of Instrumentation Problems by Pneumatic Null Balance Methods"
New Jersey	5/4/48	D68	Essex House, Newark	J. J. Heigel & C. W. Skarstrom	"Spectrographic Methods of Gas Analysis"
New York	4/28/48	DX8	Eng. Soc. Bldg.	Prof. Ralph Muller, N. Y. Univ.	"New Instrumentation Methods in the Chemical Industries"
New York	5/26/48		Eng. Soc. Bldg.	Panel Session	"What the Users Would Like the Instrument Manufacturers to Do to Improve Their Product Designs"
Niagara Frontier	5/24/48	M8	N. Y. St. Inst. Appl. Arts & Sc., Buffalo	Business Meeting.	Election of Officers
Philadelphia	4/21/48	DX8	Penn-Sheraton Hotel	Wm. M. Welch, Bell Telephone Co.	"High Waves of Communication"
Rochester	4/27/48	DX8	Univ. of Rochester	Dr. Angus Cameron, Distillation Prod. Inc.	"Why High Vacuum"
Sarnia	5/21/48	D78	Polymer Cafeteria, Sarnia	H. F. Moore, Standard Oil	"Future Trends in Instrumentation"
South Bend	5/13/48	DX8	—	Henry Schmidt, Brown Inst. Co.	"The Low Range Radiamatic"
South Texas	5/4/48	MX	U. S. Naval Air Station		Inspection Tour of Instrument Dept.
Southern Michigan	5/12/48	DXX	Chicken Charlie's, Kalamazoo	R. R. Proctor, Pure Oil Co.	"The Electronic Road Test Panel"
Tennessee	5/13/48	DX8	Franklin Club, Elizabethton	Annual Business Meeting	Election of Officers
Tulsa	5/3/48	MX	—	P. A. Elfers, Fisher Gov. Co.	"Liquid Level Control and High Pressure Regulation"
Twin Cities	5/26/48	DXX	Coffman Mem. Union, Univ. of Minn.	Movies	"Atomic Energy," "Bikini Island Tests," "Operation Crossroads"
Wayne County	5/17/48	DX8	Presb. Ch. Hall, Wyandotte	T. Cawthorne, Weston Elec. Inst. Corp.	"Electrical Instruments and New Developments"

Legend: Meeting only, no dinner—M7, MX or M8 (7 pm, 7:30 pm or 8 pm respectively) Dinner meeting—first symbol D; second symbol time of dinner (6 for 6 pm, X for 6:30 pm, 7 for 7 pm); third symbol time of meeting (7 for 7 pm, X for 7:30 pm, 8 for 8 pm).

SOUTH BEND: New Secretary—Charles E. Williams, U. S. Rubber Co., Ball Band Division, Mishawaka, Ind.

In addition, the following may be added to the chart of Regular Meeting Dates of ISA Sections published in the January, 1948, issue of the JOURNAL: Richland, 2nd Wednesday of the month.

And finally, the new Editor of the JOURNAL is H. L. Hildenbrand, Box 35, Onarga, Illinois.

Section News

CALIFORNIA

The March 2nd meeting of the California Section featured two talks and a movie. A talk on "Methods of Fabricating Plexiglas" was presented by Mr. H. H. Trump of Rohm and Haas Chemical Company, in connection with which a film, "Looking Ahead through Plexiglas," was presented through the courtesy of Rohm and Haas. A second talk, presented by R. W. Sorensen Professor of Electrical Engineering at California Institute of Technology as well as a member of the State Board of Registration for Civil and Professional Engineers, covered "The Professional Engineers' Registration Act."

Although it is felt that an active membership is more important than a large one, the California Section is working toward a goal of 300 members by the end of 1948. A prize of one year's dues is offered to the member who brings in the most new members during the remainder of 1948.

D. DWIGHT TAYLOR, *Corr.*

CENTRAL INDIANA

A large attendance of members and guests enjoyed three General Motors films featured at the March 2nd meeting at Purdue University Extension in Indianapolis. The subjects were "Remote Control," "The A-B-C of Hand Tools," and "Precisely So."

The honored guest of the evening was Mr. Harold Haskett (Instruments Publishing Company) of Chicago, who spoke briefly on the JOURNAL of the ISA and its relationship to INSTRUMENTS Magazine, of which the former is at present a section.

It was voted at this meeting to make application for affiliation with the Indianapolis Technical Societies Council.

E. E. TAYLOR, *Corr.*

CHARLESTON

Section Vice-President T. J. Kirwin presided at the short business meeting which followed dinner at the March 1st meeting. Mr. Richard Rimbach, National Executive Secretary, then outlined the progress of arrangements for the ISA Conference and Exhibit to be held in Philadelphia in September.

The first speaker of the evening was Mr. H. K. Monk, Belle Works, E. I. Dupont de-Nemours & Co. His talk was concerned with the seven qualifications required to make a man a good instrument trouble-shooter.

Mr. R. S. Jones, Carbide and Carbon Chemicals Corporation, followed with methods for trouble-shooting a pneumatic control system. His remarks were illustrated by a cumulative schematic diagram which grew from an off-on system, through proportional to automatic reset as he discussed each type.

Many questions were addressed to the speakers following their talks. During a pause for refreshments Mr. Ben Johnson gave the members an opportunity to purchase ISA recognition pins.

—MARY K. ADAMS, *Corr.*

CHICAGO

Dispensing with the usual formal lecture on any one particular subject, the March 8th meeting of the Chicago Section was devoted to a discussion of the many questions concerning the everyday problems of the instrument maintenance man. Under the technical chairmanship of L. C. Laird, Corn Products Refining Company, four experts highlighted the discussion in which well over a hundred members and guests participated.

The experts were George A. Larson, The Texas Company; R. L. Wham, Leeds & Northrup Co.; Vern Streitmatter, Victor Chemical Company; and M. V. Murphy, Lever Brothers Company. The discussion was initiated with a very general review of a training program for the apprentice, and the trend of interest and discussion subsequently shifted to questions on temperature, flow, telemetering, and pH instruments. Everything from how to make thermocouples with a carbon or mercury pool arc to a theoretical discussion of orifice constants was covered during the evening.

At the rate at which questions were asked and answered (sometimes by the

(Continued on page 374)

Basic Design and Field Performance of the Control and Measurement Instrumentation of an Alkylation Unit*

By HARRY F. MOORE and GEORGE W. GROSS (Standard Oil Development Co., Linden, N. J.)

Scope and Introduction

THE petroleum refinery unit whose control and measurement instrumentation is discussed in this paper is a commercially demonstrated one on a relatively large scale. It was designed and constructed by the Standard Oil Development Company for the Aruba Refinery in South America prior to the recent war, and became known to the petroleum industry as an alkylation plant. Its chief function was to promote an addition or "alkylation" reaction between an isoparaffin (such as isobutane) and an olefin (such as butenes) to produce isooctane. The isooctane product after purification is employed directly as one of the main components in high quality aviation gasoline fuels—commonly referred to as "100-octane" aviation gasoline.

The design principles leading to the selection of the main control and measurement instrumentation of the unit are discussed. In addition, the operating performance of the instrument installations, together with any needed modifications of the original design by the Aruba refinery instrument people, are analyzed. The authors should like to point out that it is due to the complete records which the local refinery instrument department obtained that has made such an analysis possible.

It must be stated that at the time this unit was designed, the alkylation process was a relatively new development in the petroleum field and, in fact, was just emerging from the laboratory stage. It was recognized, at the time the method and type of instrumentation was being specified, that there were a large number of exploratory variables which affected the alkylation reaction, and the most successful operation of the unit would eventually depend upon the optimum balance of these variables. Because of this situation, more than the normal allowances in design methods were employed in some items than would have been considered necessary in an established process.

In a few instances, certain control methods and types of instruments required some modification after the unit was placed in operation. The authors have attempted to discuss some such situations in order that the early experience gained may be of the most value to the readers. Operating experience on other company units has also been used to supplement the Aruba information, which was collected in June, 1941, approximately a year and a half after starting operations. Before discussing the instrumentation, a brief description is presented of the alkylation process as practiced at the time the unit was designed.

*Presented at the Second Annual Conference of the Instrument Society of America, Stevens Hotel, Chicago, Ill., Sept. 8-12, 1947.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.

The Authors

Harry F. Moore received his B.S. in Electrical Engineering from the University of Illinois in 1928. He spent the first six years following graduation in Aruba, Netherlands, West Indies, at the Aruba Refinery of the Lago Oil & Transport Co., Ltd. Four of these years were spent in the Engineering Department in construction work, and two years as head of the Instrument Department which he was largely responsible for organizing. Since 1934 he has been with the Engineering Department of Standard Oil Development Company, which is the Central Engineering and Research Organization of the Standard Oil Company of New Jersey. His work at present consists of engineering development on all phases of instrumentation, and he heads one of the best organized and well-informed instrument groups in the country.

George W. Gross obtained his degree as Bachelor of Chemical Engineering at Rensselaer Polytechnic Institute in 1938. He joined the Central Engineering and Research Organization of Standard Oil Company of New Jersey immediately after graduation and has for the past ten years been engaged in process design work for the Engineering Department of S. O. D. Company

Brief Description of Process

The commercial alkylation process may be conveniently subdivided into three main steps, namely, reaction, refrigeration, and fractionation. In the reactor section the alkylation reaction takes place. This reaction liberates heat and is carried out in the liquid phase at a temperature range of 30—40° F. using concentrated sulphuric acid as a catalyst. The raw material or feed stock to the unit is delivered to the reactor section, and consists chiefly of the various saturated and unsaturated four-carbon atom hydrocarbons boiling in the range of 10—35° F.

The desired product from the reactor section is the maximum yield of high octane aviation gasoline blending stock or "alkylate" produced from the isobutane and butene portions of the feed stock. This alkylate has a boiling range of 125° to 250° F. In addition to the alkylate product, a small percentage of high molecular structure polymers known as heavy alkylate is produced. The remaining material from the reactor section consists of the unreacted portion of the feed stock, referred to as "spent butane", plus an isobutane stream which is recycled to the reactor section. The recycle isobutane is of major importance in securing the high quality and yield of alkylate because it minimizes the reaction of the unsaturated hydrocarbons with themselves with consequent formation of heavy polymers.

The refrigeration section of the unit serves merely to supply the reactor section with sufficient refrigeration to maintain the optimum alkylation reactor temperaure. A convenional refrigeration recycle system is employed using commercial propane as the refrigerant.

The alkylation unit fractionation section serves to segregate, by means of fractionating towers and attendant equipment, the various products from the reactor section into the desired cuts of recycle isobutane, spent butane, aviation alkylate and heavy alkylate.

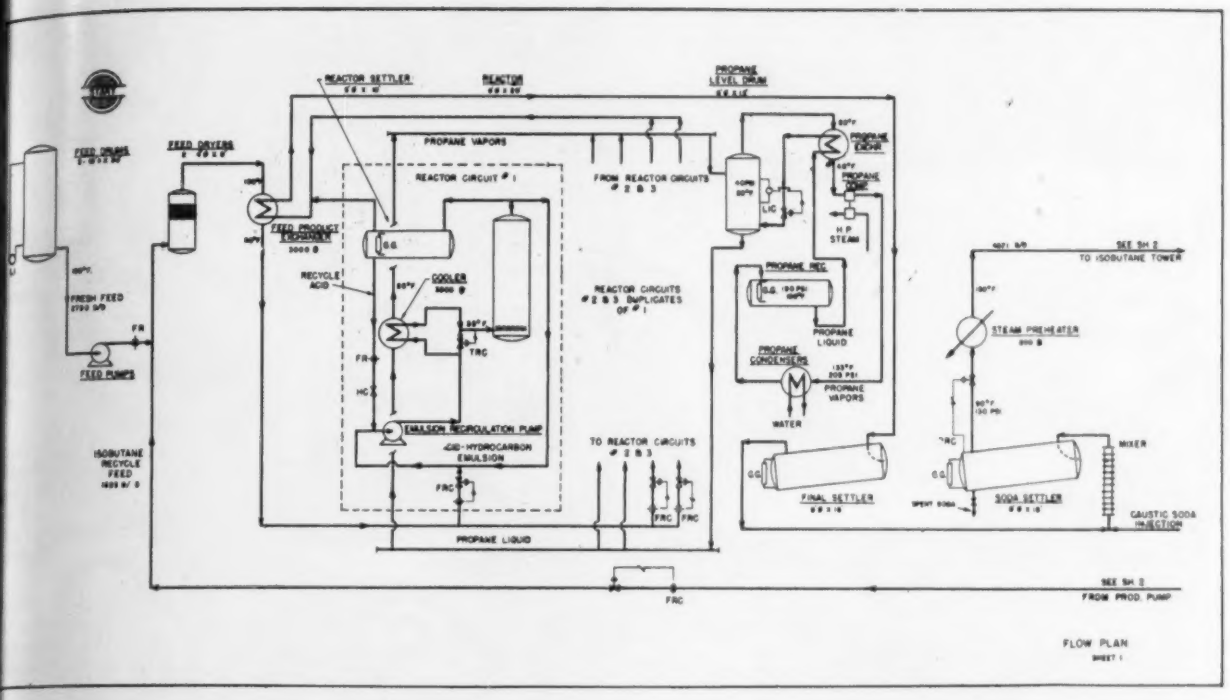
The basic flow plan of the alkylation unit illustrating schematically the processing sequence, equipment, operating conditions, and the main measurement and control instrumentation is presented as Flow Plan, Sheets 1 and 2.

Basic Design

It may be noted from the Flow Plan that the instrumentation was designed to provide continuous overall operation of the unit with the minimum of manual adjustments. At the same time, the major operating variables that affect product yield and quality in each section of the unit were fixed by automatic control instruments. For example, the quantity and ratio of isobutane and olefin feed stock to each reactor circuit was fixed by the flow controller on the isobutane recycle feed stream together with the flow controllers on the total feed to each reactor circuit. The reaction temperature was fixed by a temperature controller on the acid-hydrocarbon emulsion stream of each circuit.

The reactor products flow to the fractionating section where in each successive tower operation the desired products are continuously separated and pumped to storage under automatic control. The major operating variables such as the tower operating pressure, reflux ratio, and bottoms temperature are maintained at their desired values by automatic control instruments.

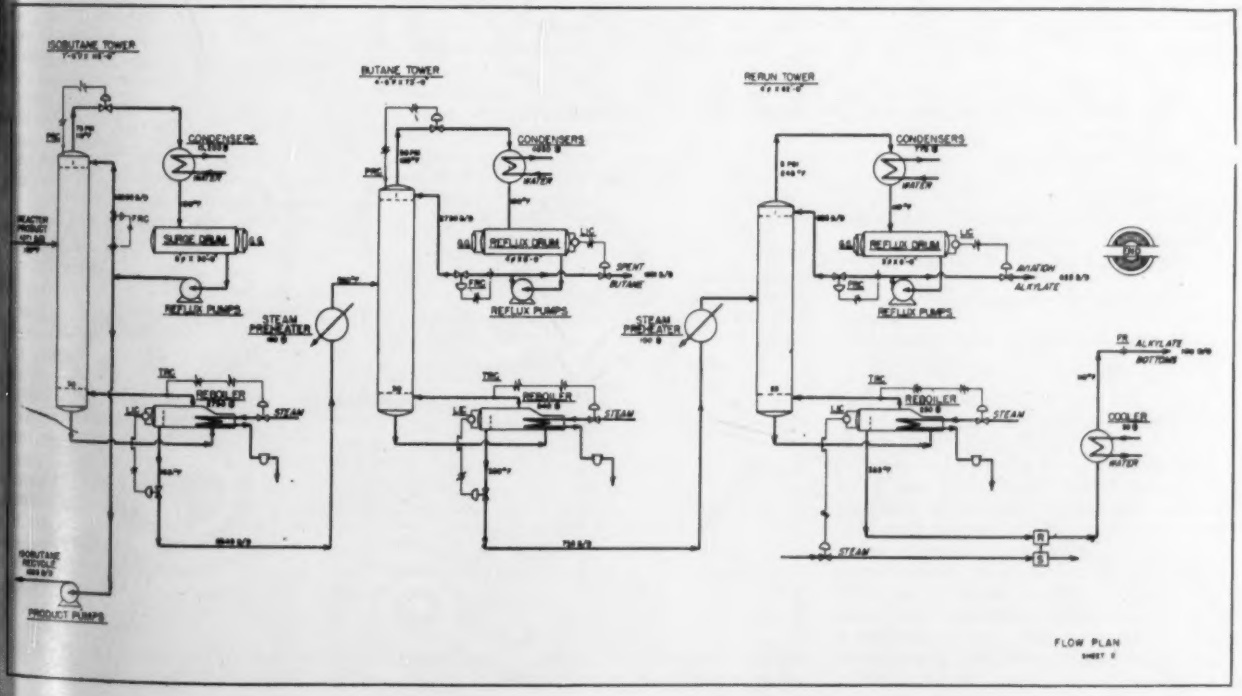
The instrumentation for each of the fractionating towers is somewhat similar. For this reason a detailed description of the basic design principles of only one of the towers will be given. The isobutane tower has been selected because it represented at the time the unit was designed in 1939 one of the first commercial large-scale precision fractionating towers of the company. The primary function of the isobutane tower was to effect a maximum separation between the isobutane and normal butane portions of the material from the reactor section. The difference between the atmospheric boiling points for these two hydrocarbons is about 20°F. The isobutane tower was designed to recover 98% of the isobutane in the mixture fed to it. The isobutane is the overhead product of the tower and is recycled to the reactor system.



Since increasing pressures effectively reduce the difference in boiling points between iso- and normal butane, it was considered economical to select the minimum tower operating pressure that would permit condensation of the isobutane overhead product with refinery cooling water in the overhead condensers. For the selected condensation temperature of 100°F., the tower operating pressure was set at 75 psi. Because the isobutane overhead product has a very narrow boiling range, essentially complete condensation is effected and gas is not normally produced from the overhead accumulator. The conventional fixed gas release valve could not be used, and a control valve in the tower line was employed.

In order to keep the heat transfer surface of the condensers to a minimum, the lowest pressure drop (consistent with good control) was necessary. The control valve in the tower line was actuated by the tower pressure controller whose pressure element was located in the upper vapor space of the tower. The tower reflux ratio was fixed by a flow controller in the reflux return line. This was considered essential in the securing of constant reflux since such factors as daily cooling water temperature variations, as well as condenser fouling, would vary the accumulator pressure which in turn would result in variations to the pumping characteristics of the reflux pumps. Control of the tower vapor line temperature, with the control valve in the reflux line, was not used because of the very narrow boiling range of the overhead vapors.

It was considered necessary to be able to set the quantity of recycle isobutane to the reactors at a desired rate dependent upon reactor conditions. Therefore, the accumulator was designed with sufficient storage to absorb the effect of the time lag in recycling isobutane from the accumulator to the reactors and back through the tower. The composition of the tower bottoms relative to isobutane was fixed by means of a temperature controller which actuated a control valve in the reboiler steam line, thereby controlling the heat input to the reboiler. The temperature element was located in the vapor line from



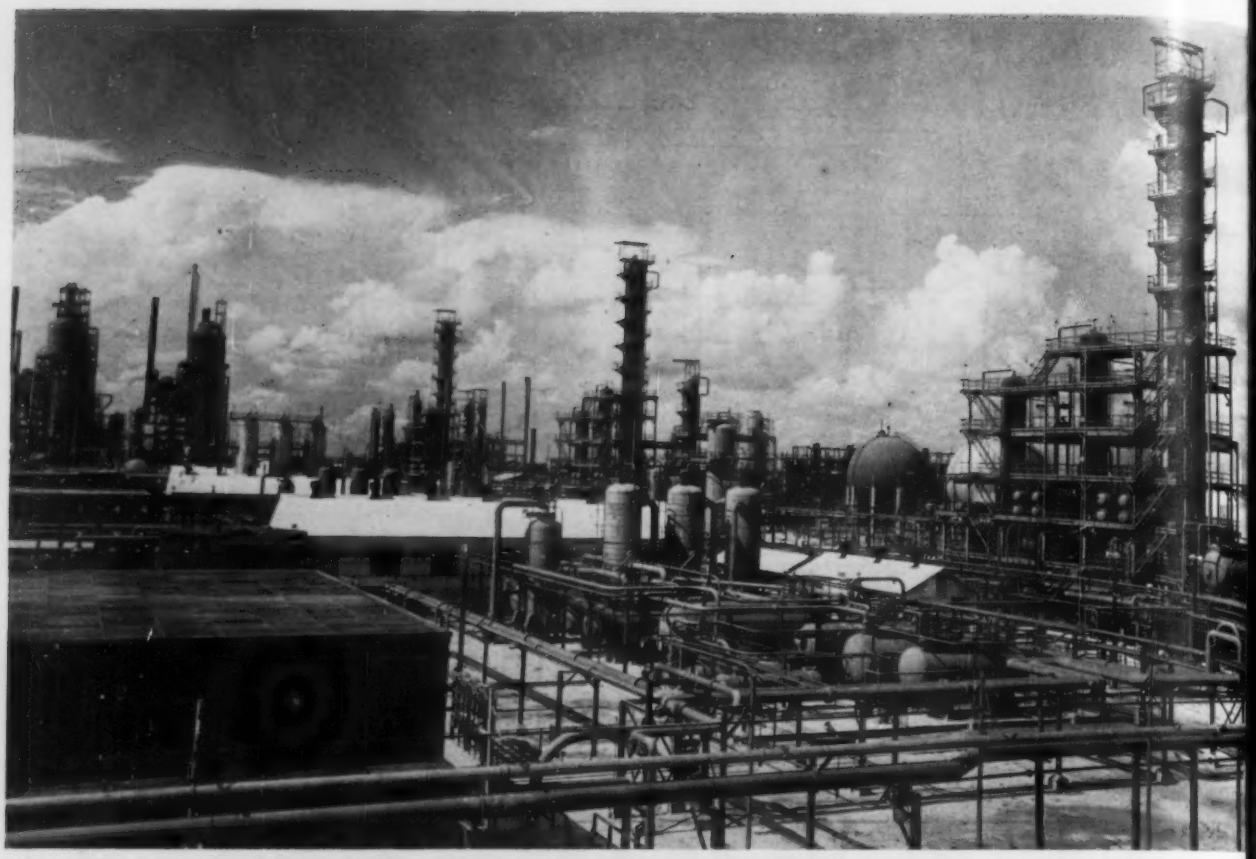


Fig. 1—General View of Alkylation Plant at Baton Rouge Refinery of Esso Standard Oil Company. This unit is typical of such installations and is similar to the Aruba Alkylation Unit described in this paper. (The structure at the right of the photograph consists of, from right to left, the isobutane, butane and rerun towers. In the foreground, the three larger insulated vertical drums are the reactors, while the horizontal drums are the reactor coolers and settling drums. The building which can be seen behind the reactors is the compressor house for the refrigeration system, and the building in the center of the photograph is the control house.)

the reboiler. The feed preheater, which was the other source of tower heat input, was under manual control since it represented less than 10% of the total heat input to the tower.

The tower bottoms product was continuously removed from the reboiler accumulator section by means of a level controller. It was considered imperative that the flow stability of this level controller be as excellent as practical to minimize variations in feed rate to the butane tower.

It may be seen, therefore, that the major operating variables were placed under automatic control. The remaining free major variable was the composition of the tower overhead which was dictated by the "built-in" features of the tower. These features include the number and the efficiency of the bubble-cap type plates provided in the tower.

Field Performance

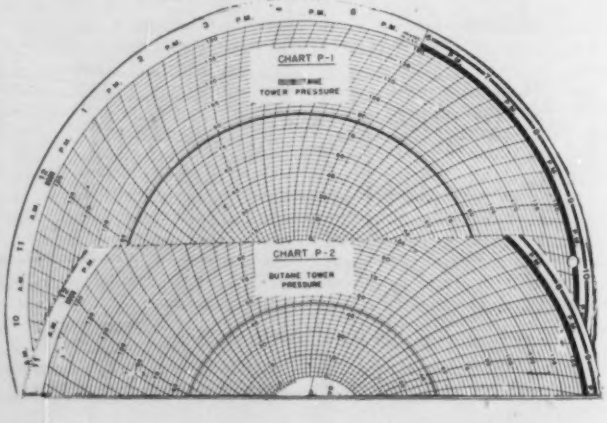
Pressure Measurement and Control

(Isobutane and Butane Towers)

Charts P-1 and P-2 illustrate typical tower pressure records with control by means of vapor line valves. Consistently good results were obtained at Aruba, and also at other locations. Table 1 indicates one early trouble caused by large unbalance of forces on the butterfly valve positioners. No one today would attempt to use a diaphragm operated butterfly valve without a valve positioner. In 1939, however, two conditions existed which led to omitting them in the original design. These were (1) lack of experience with butterfly valves, so that their high torque requirements came as a surprise, and (2) valve positioners available were either flimsy or unstable, so that their use was held to a minimum.

Experience with the butterfly valves was very interesting. First came the matter of sizing. Information available on their capacities was meagre, and the sizing had to be done in a somewhat arbitrary manner. The sizing proved to be remarkably good. Secondly, torque or force requirements of these valves is high compared to the conventional control valves, as indicated by the need for valve positioners. Even with the positioner in service and process conditions stable it was noted that diaphragm pressure fluctuated rapidly (not in a cyclic manner, but in an aimless way) as much as 15% of the normal operating range of 12 psi while air pressure from the controller was unchanged. This is ample evidence of the under-powering of these valve operators. The concluding evidence came on a subsequent unit, when it was found impossible to operate the isobutane tower valve beyond 25% open position due to inability of the diaphragm motor to move the butterfly vane against internal forces. Before this condition was remedied the diaphragm effective area was approximately doubled and the operating air pressure range increased from 12 to 20 psi.

Chart P-2 shows a slight "saw-tooth ing" which was frequently encountered on these butterfly installations, particularly when operating with the but



fly vane in the nearly-closed position. Although these slight pressure fluctuations had no apparent effect on operation, they should be eliminated when it is possible to do so. The importance of this isobutane tower is obvious when it is considered that a change in tower top pressure of 1 pound per square inch demands a change in temperature of almost 1°F.

This inter-relation of temperature and pressure is illustrated by Charts T-4 and T-5, and P-3 and P-4 which were obtained from another tower. Charts P-3 and T-4 cover the same time interval, as do P-4 and T-5. The tower pressure was fluctuating due to improper control valve action (control valve located in water supply line to overhead condensers). As a result, the tower temperatures fluctuated, even though the reboiler temperature controller was attempting to compensate. When the pressure control was straightened out (Chart P-4) the temperature control record immediately stabilized (Chart T-5). This, incidentally, is a perfect example of the need for intelligent analysis of so-called "instrument trouble." No amount of work on the temperature controller alone was going to save the situation. The old question of whether the egg or the hen came first is of utmost importance.

From the work done on an isoprene fractionating tower, it is felt that improved control of the tower pressures would be obtained by suppressing the zero point of the range, thus using an amplified scale. In some respects this would be similar to what has been done in replacing the galvanometers of pyrometers with amplifiers which allow narrow temperature spans. It is known that two instrument manufacturers are doing some work on such amplified pressure instruments. It is not improbable that precision amplified measurement of tower pressures, with consequent improved control, could furnish the answer to the tower bottom temperature control troubles in the Aruba unit.

Temperature Measurement and Control

(Fractionation Section)

The temperature control originally provided on the isobutane tower reboiler was unsatisfactory, and Table 1 indicates that after some improvement, attributed to a change in instrument type, automatic control was abandoned. This history was repeated on several other isobutane tower installations. Chart T-1 shows a typical temperature control record, taken from another isobutane tower prior to abandoning automatic control.

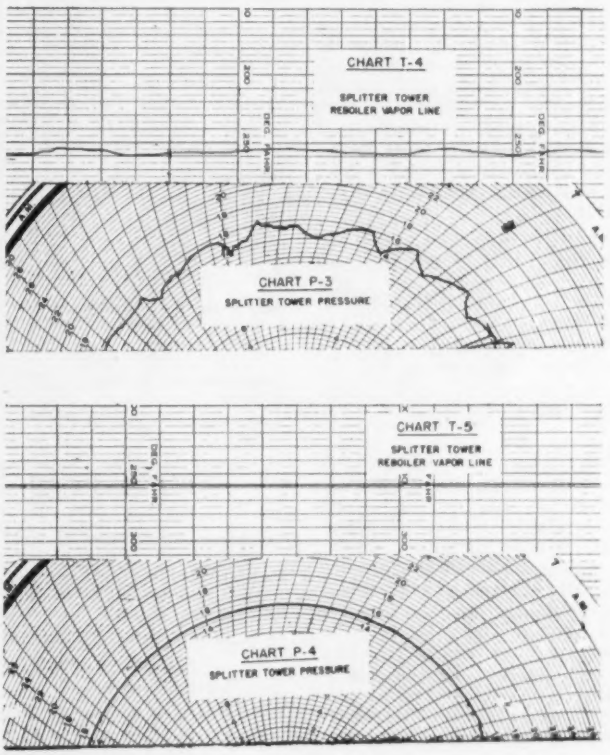
Subsequently various attempts were made to improve isobutane tower control. These included measurement of differential pressure across the tower, automatic bottoms heat control by temperature at the 13th plate, and automatic bottoms heat control by differential temperature across a 10-plate tower section. This last method is reported to be satisfactory.

This temperature control application was confronted with several interesting service conditions. First and foremost, instrument engineers observing tower operation were amazed at the time it took for a change in reboiler steam flow to be reflected in temperature change throughout the tower. Intervals of 5 to 10 minutes were measured, for a large steam flow change to begin changing the 13th plate temperature. On hand control it was felt by many operators that one change per 30-minute period was the maximum that could be made without danger of serious upsets. In the rough and ready language of the refinery it was said "make a change today and see the effect tomorrow."

A second item which contributed its share to the problem was an old "friend" of temperature control, namely condensate removal. With the reboiler temperature around 150°F., and heat transfer surface designed for exhaust steam, a reboiler steam pressure below atmospheric was expected. To discharge the condensate, the Aruba unit was designed with a condensate drum vented back to the reboiler. A level controller operated a pump discharging the vacuum condensate to the regular system. Other units were designed with so-called "pumping traps."

a 100° F. span iron-constantan pyrometer of the galvanometer type. This proved unsatisfactory, due to the limits of industrial galvanometer characteristics, and the range was changed to 350° F. Recent developments in pyrometers without galvanometers, using electronic amplification, have allowed the use of the narrow ranges, with excellent results.

The question could be raised, "Why not use resistance thermometers?" This was done on some pure product work, with good *operating* results. Resistance thermometers, however, are heartily disliked in refineries due to (1) the need for soldering of joints, with a consequent safety problem whenever a bulb must be replaced, (2) resistance troubles wherever contacts or switches are involved, due to corrosive nature of refinery atmospheres, and (3) fragility of most bulb designs as compared to thermocouples.



These traps proved to be consistently troublesome and some of the control difficulties were traced to their operation. Because of these difficulties, together with other data which became available, subsequent designs dispensed with the reboiler trap altogether by installing the control valve in the condensate line and putting full steam header pressure in the reboiler tubes. This type of installation, while it is no panacea, has given consistently good results on temperature control applications.

The isobutane tower application and later, during the war, the butadiene, toluene and isoprene fractionation applications focused attention on the basic need in pure product fractionation work for temperature equipment with small temperature spans, so that 1° F. can be seen on the chart and represent enough physical movement to allow proper control response. On one early job an attempt was made to use

A scrutiny of the Aruba isobutane tower control application brings out the fact that the fundamental requirement is to run for minimum loss of isobutane in the tower bottoms. Thus, control by temperature is essentially indirect control. Control by analysis for isobutane in the bottoms would be highly desirable. The infra-red absorption analyzers offer some hope along this line, and trial installations are now being tested.

(Reactor Circuit Coolers)

Removal of heat in the reaction zone involved control of large amounts of refrigeration. Early designs such as the Aruba unit, built with little background knowledge on this point, were provided with individual circuit temperature controllers, to allow for possible variations in the alkylation reaction in the three circuits, uneven results in the heat exchanger type coolers, etc.

The tabulation (Table 1) shows the field result to be "Instrument not needed. Temperature held constant by automatic control of refrigerant compressor suction pressure." Chart T-3, temperature of feed from a reactor cooler, illustrates the constant temperature obtained. As a result of this experience, the temperature control equipment was removed for use elsewhere in the refinery. Subsequent plant designs omitted the temperature controllers.

Level Control

Continuous processes have many pieces of inter-related equipment, as amply illustrated by the Flow Sheet. As a result of inter-relationship one of the primary requirements of satisfactory processing is stability of the temperatures, pressures and flows. These temperatures, pressures and flows could be held stable even with hand adjustment of valves by building such storage spaces as reflex drums, tower bottoms and vapor spaces large relative to the flow rates. By "large" is meant a storage space equal to 15 to 30 minutes of flow. This much storage causes such inertia or "flywheel" effect that the temperatures, pressures and levels change slowly, even though the flow rates set by hand operated valves are appreciably away from the proper average value.

To build the storage spaces this large would add considerably to the required investment and in some cases would raise questions of practicality. The actual holdup time in most cases was in the order of magnitude of two minutes. The butane tower reflex drum, for example, had a holdup time of 1½ minutes based on reflex plus product withdrawal.

The maintenance of stable process conditions with such small storage space between the inter-related pieces of equipment is one of the jobs which justifies the expense of the control equipment installations. In engineering the control installations and in selecting the equipment it is, therefore, essential that consideration be given at all times to the question of stability. Several papers dealing with a mathematical analysis of such problems have recently appeared in the literature. Such methods are not used by industry as (a) the mathematical analysis is at best satisfactory only for a single or two capacity process, (b) the assumptions necessary to such an analysis cannot be set with any reasonable precision, and (c) a mathematical analysis assumes instruments in infinite responsiveness and linear relationships. With reference to the last points of responsiveness and linearity, the instrumentation of this 1939 design and also of present 1947 designs misses both by uncomfortably wide margins.

In place of a mathematical analysis, the guidepost used in the design work was based on experience with storage, or "holdup time" as it is sometimes called. For example, on level control the volume of liquid within the range of the level controller, expressed in terms of the number of minutes of flow rate it represents, is the major consideration. The second consideration is the need for stability (excellent, moderate or unimportant) as established from a study of the process together with experience.

TABLE I. Tabulation of Instrumentation Changes

(for purposes of this paper, tabulation covers only those instrument applications discussed in body of paper.)

Application	Instrument	Changes	Reason
Pressure: Propane Level Control Drum	Indicating controller with adj. prop. band and adj. reset.	None	—
Pressure: Isobutane Tower	Recording controller with adj. prop. band and adj. reset.	None to instrument	—
	Valve, 10 in., air operated butterfly.	Installed valve positioner	Perfect control of tower pressure is essential, for which positioner was needed. Control now very satisfactory.
Pressure: Butane Tower	Recording controller with adj. prop. band and adj. reset.	None to instrument	—
	Valve, 6 in. air operated butterfly.	Installed valve positioner	Perfect control of tower pressure is essential, for which positioner was needed. Control now very satisfactory.
Flow: No. 1 Circuit Feed	Mercury manom., pneumatic transmission recording controller with adj. prop. band.	Adj. reset added to controller. Orifice size increased	Prop. control caused wandering of control point, due to line pressure changes. Rate at full meter differential changed from 3500 to 5100 G/H.
Flow: No. 2 Circuit Feed	Mercury manom., pneumatic transmission recording controller with adj. prop. band.	Adj. reset added to controller. Orifice size increased.	Prop. control caused wandering of control point, due to line pressure changes. Rate at full meter differential changed from 3500 to 5100 G/H
Flow: No. 3 Circuit Feed	Mercury manom., pneumatic transmission recording controller with adj. prop. band.	Adj. reset added to controller. Orifice size increased.	Prop. control caused wandering of control point, due to line pressure changes. Rate at full meter differential changed from 3500 to 5100 G/H
Flow: Recycle Isobutane	Mercury manom., pneumatic transmission recording controller with adj. prop. band. Reflux accumulator record on same chart.	None	—
Temperature: No. 1 Circuit Cooler	Potentiometer recorder controller with adj. prop band and adj. reset	Instrument removed	Not required. Temp. is controlled indirectly by pressure control of refrigeration compressor suction.
Temperature: No. 2 Circuit Cooler	" " " " "	" "	" " " " "
Temperature: No. 3 Circuit Cooler	" " " " "	" "	" " " " "
Temperature: Isobutane Tower Reboiler Vapor	Potentiometer recorder controller with adj. prop. band. and adj. reset.	Replaced with indicator controller with more direct mechanical tie-in from galv. to control mechanism.	Control not satisfactory. Better with replacement, but hand control preferred by operators.
Temperature: Butane Tower Reboiler Vapor	" " " " "	None	—
Level: Rerun Tower Accumulator	10 inch range ball float indicating level controller with adj. prop. band (to max. of 80% & adj. reset. Float also operates switches for 3-light signal.	Reset removed	Due to action of reset, alkylate to storage flow rate was unstable, even with slowest reset. Inst. now satisfactory.
Level: Isobutane Tower Reboiler	" " " " "	Replaced by control mech. allowing adj. prop. band to approx. 1500% reset included.	More stable flow was required and obtained.
Level: Spent Butane Accumulator (Butane Tower Reflex Drum)	" " " " " except reset omitted.	None	—

Chart L-1 shows the record of flow through the butane tower reflex drum level control valve. This is not a stable record as the flow rate changes abruptly at unpredictable times. This is true despite the fact that flow of condensed vapor to the drum and reflex from the drum were entirely stable. The jumpy action is the result of the inability of a short range ball float level controller to follow the level closely, plus the fact that it is not unusual for the level of such a drum to change one-half inch or so for no apparent reason. Half an inch on an 8-inch range with a maximum proportional band setting of 100% represents a large change in control valve opening, with a consequent large change in flow rate through the control valve.

Experience on many units indicates that an 8-inch ball float level controller, even when connected to the control instrument through a grease-packed stuffing box, can not be counted on to do any better job than is indicated by Chart L-1. In fact, Chart L-1 represents as stable a flow as has been seen from such an instrument. Charts L-2 and L-3, which are taken from a similar process unit at another location are more typical of the unstable flow to be expected.

Process units currently being designed are being provided with either the differential type or the displacement type level controllers. The differential type utilizes a mercury manometer, bellows, or force balance device to measure the level. The primary elements of these devices are very similar to those used for flow measurement.

The displacement type utilizes a relatively long tubular member which is

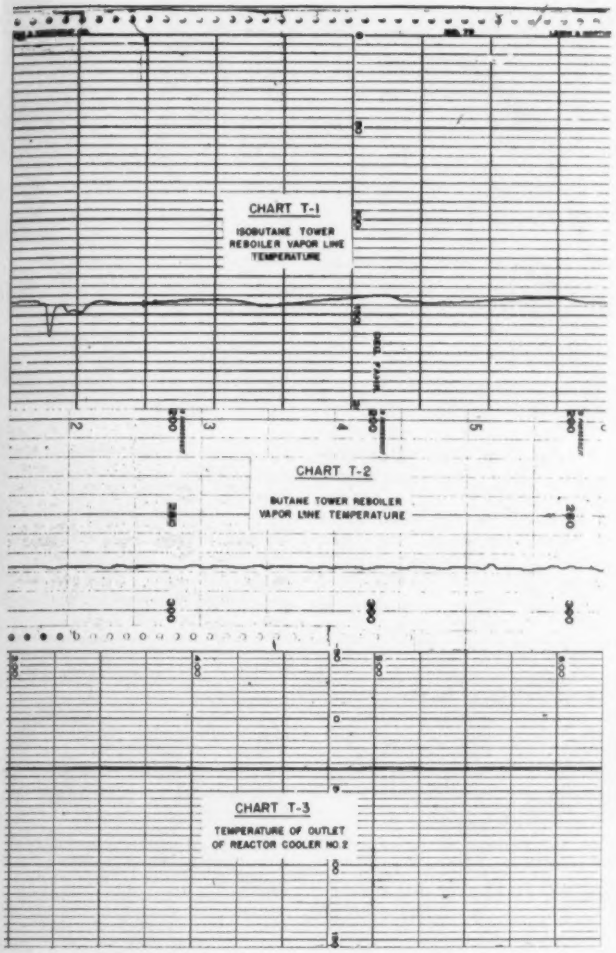
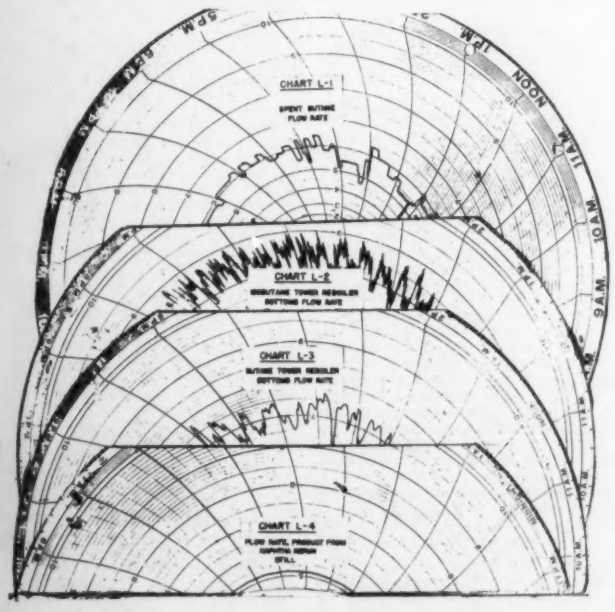


CHART T-1
ISOBUTANE TOWER REBOILER VAPOR LINE TEMPERATURE
CHART T-2
BUTANE TOWER REBOILER VAPOR LINE TEMPERATURE
CHART T-3
TEMPERATURE OF OUTLET OF REACTOR COOLER NO. 2



eighted that it always tends to sink. he measurement of level in such a ase is made by weighing the tubular isplacer member and calibrating the nstrument directly in terms of level. These two types have proven satisactory where the ball float has not. he difference is considered to be due o (1) ability of the instrument to pick p changes in level that the ball float id not pick up; and, (2) ranges are kept long as compared to the short ball float travel, such that a level change of ½-inch represents a much smaller change in control valve position. In effect, this latter point is equivalent to saying that the proportional band in terms of inches of level had been widened enormously. In addition, where the ball float instrument was usually limited to 100% proportional band, instruments on current jobs have adjustments which go to several times this value.

The excellent results obtained with the differential and displacer types are typified in Chart L-4. This float chart was obtained on an application in which a ball float type instrument was replaced by a long range (36 inches) differential type, due to inability of the ball float equipment to give stable flow.

Control Action

For control of continuous processes a discussion of types of control action required is always of interest. Examination of the charts and of the record of changes uncovers the following points:

Flow Control

The flow controllers on the Aruba unit were of the mercury manometer, pneumatic transmission type, with proportional control action. Reset was not originally included but the tabulation shows that reset was added to the three circuit flow controllers. Charts C-1 and C-2 are typical of the results obtainable with proportional control alone. Such results are not perfect flow control. The offsetting of the record occurs when load or pressure changes take place. Such offsetting is inherent when proportional control is used alone. The minimum proportional band setting in such cases is approximately 10%.

In order to obtain stable non-cyclic flow control with such a narrow proportional band, it is necessary to severely restrict the opening of the adjustable needle valve in the mercury manometer connecting U-tube. This naturally impairs the responsiveness of the metering portion of the control installation, but the U-tube can not be opened further without a larger proportional band setting being required for non-cyclic control, with consequent larger offsets. For an unrestricted U-tube, the required setting was found to be in the range of 40% to 60%.

Thus, for "compass circle" flow control, with or without a restricted U-tube, reset is essential. For an unrestricted U-tube reset must be employed or offsets will be so large that they will destroy any semblance of the flow record to flow control. Since obtaining this field experience in 1939 and 1940 all flow controllers have been specified with reset.

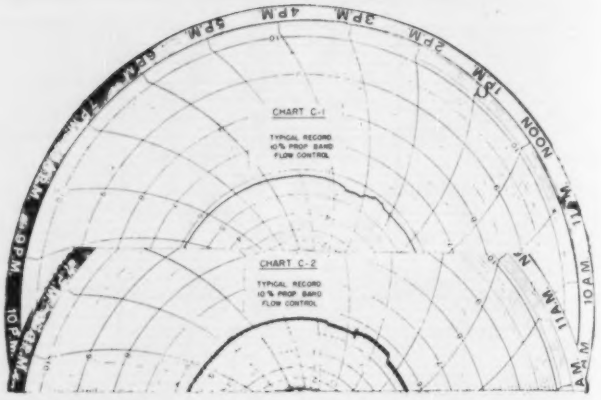
Level Control

In theoretical discussions of level control the point is sometimes made that with any given set of conditions, and with proportional control only, the stability of flow through the valve will suffer somewhat if reset is added. This is readily apparent when it is considered that with a low level, for instance, the action of the reset is to close the valve beyond what the proportional control calls for, in order to drive the level back to the set point.

As mentioned, this is a theoretical point. Thus, it is of interest that the tabulation in Table 1 under "Liquid Level, Rerun Tower Reflex Drum" indicates that the point was demonstrated. The original application incorporated proportional plus reset action. The comment is "due to action of automatic reset, the alkylate flow to storage was unstable, even with slowest reset rate. Results satisfactory after change to proportional control only."

In view of the above, the comment under "Liquid Level, Isobutane Tower Reboiler" may be confusing. The original equipment was identical to the level controller on the rerun tower reflux drum. The flow record, as in the rerun tower reflex drum application, was not sufficiently stable. The correction, however, was quite different. An instrument was used which retained reset, but incorporated proportional band adjustability to approximately 1500%. It is unfortunate that flow charts are unavailable to show flow stability obtained before and after the change. The recorded observation in the tabulation of Table 1, plus records of the butane tower operation, show that the change produced the required flow stability. Any consideration of this type of instrument must be tempered with the thought that as soon as the level deviates four inches from the set point (mid-point of instrument range) the limit stops come into use, with the resultant large change in flow rate.

Fundamentally, although the changes to the two level control installations



referred to produced a desired corrective action, th ball float equipment, with its short range of 8 inches, accentuates level control to the detriment of flow stability and does not take advantage of the storage which is built into the process equipment. To the level controller, only that storage within its range is usable. The remainder is unused. The fundamentally correct approach, used in subsequent designs, is to accent flow stability by allowing the level to vary within the full height of the storage by means of instruments with a range equal to storage limits, and large proportional bands.

Section News

(Continued from page 367)

experts and sometimes by audience volunteers), it was evident that instrument men like nothing better than to talk about instruments.

—MAX E. KAUFMAN, *Corr.*

CUMBERLAND

The Cumberland Section held its regular monthly dinner meeting Tuesday, February 24, at the Hotel Algonquin. The speaker of the evening was Mr. D. E. Garr, General Electric Company, Schenectady, N. Y.

The subject of Mr. Garr's talk was "Electric Positioning Systems of High Accuracy for Industrial Use." The talk concerned servo-mechanisms as used in relatively powerful positioning systems and their application to process control. His very interesting talk was well illustrated with slides.

G. WILLIAM HARRISON, *Corr.*

DETROIT

The January meeting featured Mr. T. S. Cawthorne who described the various types of instruments used in A-C measurements; outlined the fields of use of various types of measuring elements, and their accuracy in relation to various conditions of frequency and wave-form. He also covered the history of certain types of meters and the various methods of primary calibration. During the question period one question in particular struck ye correspondent's bump of curiosity, "At what frequency does a current cease to be a-c and become d-c?"

The February meeting was highlighted by a very complete discussion of the "Character and Application of Thermistors," presented by Mr. J. E. Tweeddale of Western Electric Company. Mr. Tweeddale described the Thermistor as a very efficient temperature-sensitive conversion element having a negative temperature coefficient, and explained a number of applications of thermistors in thermometry, as a bolometer for use in infra-red spectrometry, in vacuum systems, anemometers, and as an automatic gain control in vacuum tube amplifiers.

The non-credit course in instrumentation recently inaugurated by the University of Michigan at the instigation of the Detroit Section of the ISA, started off very successfully with 71 in attendance, including one of the fair sex. Members Jim Gambrill and Tom Nisbet of the Section Education Committee, who were responsible for starting the train of events that culminated in this course, deserve our sincere thanks for their part in making the course available to instrument men and women in this area.

W. E. WILSON, *Corr.*

EASTERN NEW YORK

The March 2nd meeting, held at Siena College in Loudonville, featured Mr. Perry Borden of the Bristol Company, who braved some very inclement weather in order to address a small (for the same reason) but appreciative audience on the subject of "Telemetering."

Mr. Borden touched briefly on the early history of "Telemetering" and then discussed, in essence the various methods and modern means of the subject.

So appreciative was the audience that the meeting had to be adjourned at 10:30 so that those who had to drive home through the sleet and snow storm would arrive at their destinations by morning.

—W. J. CLAFFIE, JR., *Corr.*

GULF COAST

The Gulf Coast Section held its March meeting on Tuesday, the 23d, at Lamar College, Beaumont. Mr. R. L. Nichols, Instrument Foreman at Magnolia Petroleum Company, and Director of this Section, led a discussion on "Control of Reboilers." Slides and drawings were used to illustrate the discussion.

Forty members and visitors were present, most of whom entered into the lively question and answer period.

—A. E. BUNN, *Sec'y.*

KANSAS CITY

On February 24th the Kansas City Section met at the Crossroads. The basic lecture, "Air Control", was presented by Gordon Burke, of Burke Engineering Company of Kansas City. After explaining the direct acting pressure regulator, the self-contained temperature controller, and the lever type liquid level controller, he then developed the principle of the simple pilot operated air control system.

The speaker of the evening was Oliver L. Boutros of Boutros Instrument Laboratory, Kansas City, who presented an illustrated lecture on "High Speed Photographic Exposure." The talk dealt with the principal instrument aspects of the Light Integrator, which sums up the total amount of light during a 5 to 100 microsecond exposure. He had with him experimental samples of the instruments used. In addition, he showed the Western Electric Company's "Fastax" film.

Everyone present thoroughly enjoyed this "local talent" program.

—W. A. REICHOW, *Corr.*

LOUISVILLE

A "Stump the Experts" program was presented at the February 24th meeting of the Louisville Section. The experts, chosen from the local membership, were Messrs. Delmas C. Little, Pearce Grose, Melvin Johnson and Allen Cook. E. H. C. Brown acted as chairman and kept the ball rolling. Questions from the floor began with "Exactly why does a Bourdon tube tend to uncurl under pressure?" This simple beginning broke the ice and questions began to pop from all sides, leading to developments and ramifications which were at times very absorbing.

Two films from the General Electric Company's film library concluded the meeting.

A dinner meeting is planned for April 27th, the speaker to be Mr. Sid Parks and the subject "Aerial Photography."

NEW JERSEY

The New Jersey Section was privileged to hear one of its own members at the regular meeting on Tuesday, March 2, at the Essex House in Newark. Approximately 100 members and their guests heard Clifford B. Ives, Chief Engineer of Kieley-Mueller, Inc., present an interesting and educational talk on "Basic Considerations in the Design of Modern Control Valves."

Mr. Ives used a new approach to the control valve topic by restricting his discussion to the problems of design and manufacture. His daily contact with these problems was evident throughout the presentation. His talk covered such things as body shape (and why it differs from that of a globe valve), the importance of diaphragm effective areas, spring rates and tolerances, selection of diaphragm pressure range, seating and balancing of semi-balanced inner valves, etc.

The speaker also touched on the problems confronting the valve manufacturers as a result of the industry's study for standardizing the face-to-face dimensions of control valves.

Following the talk, a lively question and answer session was held.

In conformance with the usual practice of having a manufacturer's display of equipment at the meeting for inspection, the Carson Micrometer Corporation had a very interesting display of several types of electronic micrometers.

—H. F. MOORE, L. H. BALLINGER.

NEW YORK

Sixty-eight members and guests attended the fifty-sixth meeting of the New York Section at the Engineering Societies Building, February 25, 1948. During the business session, President Ralph Batcher received comments on the new meeting facilities.

Mr. Kalbfleisch was appointed chairman of the membership committee, and Professor Carl Kayan introduced plans for the proposed 1949 conference to be held in New York. This conference will be devoted mainly to the subject of Pressure Sensitive Devices in Modern Instrumentation.

The speaker at the technical session was Mr. Ward O'Connor of the Lummus Company, and his subject was "Presenting the Contractor's Point of View on Plant Instrumentation." Mr. O'Connor described and illustrated a centralized control system in which all information is transmitted to one location, and from which variables can be changed to maintain proper operating conditions. A secondary, but important, point discussed was the standardization of the physical dimensions of instrument valves, connectors and accessories.

—EDWARD B. SCHOFIELD, *Corr.*

NIAGARA FRONTIER

The regular monthly meeting of the Niagara Frontier Section was held on February 23rd at the New York State Institute of Applied Arts and Sciences in Buffalo. A short business meetings was held after which President Clarence Boltz introduced

Mr. L. P. Haner, the speaker of the evening. Mr. Haner's subject was "The Problems in Establishing an Industrial Electronics Research Laboratory."

Mr. Haner is in charge of, and recently established, the Industrial Electronics Research Laboratory at the E. I. DuPont deNemours & Company River Road Plant in Buffalo. He was therefore extremely well qualified to speak on this subject, and his talk, accompanied by slides showing various kinds of equipment, was of very definite interest to all present.

Mr. Haner opened his talk with a very simple but precise definition of "electronics" carried through with description and application of various types of electronic equipment, and closed with a summary of ethical and engineering standards which should well be applied to all types of equipment.

—W. J. SOMMERS, *Corr.*

NIAGARA FRONTIER

The March meeting of the Niagara Frontier Section was held on the 22nd at the New York State Institute of Applied Arts & Sciences in Buffalo.

The speaker of the evening was Dr. Joseph A. Bergantz, Chemical Engineer at the Buffalo Electricochemical Co., Inc., Tonawanda, N. Y. whose subject was "Instruments and Atomic Energy." Dr. Bergantz, as an army officer during the war, was connected with the Manhattan District Project. He explained very interestingly several of the processes carried out at Oak Ridge and the Hanford Plant in the State of Washington, and described briefly these projects indicating the immensity of their size. Dr. Bergantz brought out the fact that the Manhattan District function was procurement only, and that he and his fellow workers were as much surprised as anyone else when the first bomb was dropped at Hiroshima.

During the question period following this interesting talk, the discussion centered around radio-activity given off by workers as they filed out at the end of their shift, as indicated by Geiger counters. Dr. Bergantz stressed the fact that the processes carried out at Oak Ridge would have been impossible without instrumentation, the 11 mile long instrument panel not only did the job efficiently, but contributed in great measure to the fact that not one single life was lost through exposure to radioactive material. Instrumentation made remote control possible.

Following the speaker, nominating committee chairman George Kellner directed a brief discussion of nominations for officers to be elected at the April meeting. As nominations were deemed incomplete at the end of this discussion, it was decided that a complete list of those names be published in the next issue of the "Frontier Transmitter," to be released about April 19.

—W. J. SOMMERS, *Corr.*

OAK RIDGE

The 23rd meeting of the Oak Ridge Section, held March 3, 1948, was opened with a brief but excellent report on the financial picture of our recent "smoker." (For business-minded readers, the actual cash outlay amounted to less than $30, whereas more than four times this amount had been appropriated for the affair. For the secret of success write our committee chairman, W. J. Ladniak, 317 E. Fernhill, Oak Ridge.) Several new members were acquired as a result of the smoker.

The speaker of the evening was Mr. W. W. Wills, Director of Research, Brown Instrument Company, whose topic, "Electronic Potentiometers as Applied to Voltage and Current Measurements," was found to be most educational and well presented.

"Walt" Wills, being and old Prof. at Lehigh and Haverford Universities, was right at home with the blackboard and indicate circuits. Pointing out the characteristics of each component part and the interrelationship between elements, he gave the audience a detailed schooling on the entire unit. Indeed, it was an evening well spent.

—J. O. ALEXANDER, *Corr.*

RICHLAND

President E. See Day opened the regular February meeting at the Sacajawea School with 90 members and 15 visitors present. L. Pollock of the membership committee reported 115 members have joined the Richland Section and more are expected soon. It is felt that this is a fair number for a section only three months old, and should place Richland among the larger new Sections.

The first draft of the Constitution and By-Laws was presented by H. C. Bodmer, as prepared by the Constitution Committee. If it is acceptable to the majority it will be approved at the next meeting.

Mr. H. T. Sawyer, Seattle manager of the Bailey Meter Company, presented the principal address of the evening on the subject, "Flow Measurement." He discussed the various primary flow measuring elements and described some of the problems that come up when one is asked to measure certain types of flow. Different types of indicating and recording instruments were explained and illustrated.

The talk was capably presented and aroused considerable interest. A stimulating question and answer period concluded this part of the program.

Concluding the evening, the General Electric sound movie, "Naturally It's F-M", was shown. It explained in simple language the fundamentals of A-M and F-M broadcasting.

Following adjournment the group enjoyed tasty refreshments arranged for by the program committee. —JOHN FLICKINGER, *Corr.*

ST. LOUIS

The St. Louis Section enjoyed the largest turnout of the season at the March meeting on Wednesday, the third, when more than 150 members and guests attended the demonstration and lecture by Mr. Richard N. Pond of Taylor Instrument Companies on the subject "Basic Control Principles."

Mr. Pond began by discussing the various control actions which may be incorporated in a control mechanism, and showed curves illustrating the effect of each of the control actions—on-off, proportional, reset, and preact or rate control. The elaborate demonstration equipment was then put into operation and the various methods of control were applied to an actual process, with the results being shown on a specially constructed 30-inch strip-chart recorder.

Mr. Pond and the Taylor Instrument Companies are to be complimented on the masterful job in presenting clearly and concisely the difficulties presented in control problems, and the methods available for their solution. The educational job they are doing should make possible the design of more processes along controllable lines, as the factors making for a controllable process are emphasized.—H. E. ZEFFREN, *Corr.*

SOUTH BEND

The South Bend Section held its annual election of officers on February 12, 1948. The offices were filled as follows:

President—George E. Gilliam, Brown Instrument Company.
Vice-President—Orvel Riggs
Treasurer—Marius Wolf, U. S. Rubber Co.
Secretary—Charles E. Williams, U. S. Rubber Co., Mishawaka, Ind.
Director—Prof. J. G. Buck, University of Notre Dame

These officers assumed their new duties at the March meeting, held on Thursday, March 4th, at which meeting Dr. Bernard Waldman, Associate Professor of Physics, University of Notre Dame spoke on "Some Instrumentation in Atomic Energy."

—MARIUS WOLF, *Corr.*

SOUTH TEXAS

The South Texas Section held its monthly meeting Tuesday evening, March 2, in the Central Power & Light Company auditorium.

The meeting was conducted by Vice-President Cecil Carson in the absence of President William Rock who, much to the surprise and regret of the membership, has been transferred to Houston. Mr. Carson was assisted by Executive Secretary and Director Homer Givens, who has never missed a meeting nor lost an election, although he drives 80 miles to attend meetings.

The confused speaker of the evening was ye scribe, who spoke on the history of aircraft instruments, and the pioneers in the development thereof. The talk was made without incident, the members having been searched for concealed vegetables before entering.

We are hopeful that arrangements can be made in the near future for meshing our meetings schedule with those of the Houston and Beaumont (Gulf Coast) groups. —L. NEEDHAM, *Corr.*

SOUTHERN MICHIGAN

(Received too late for the March issue)

The speaker at the February meeting was Mr. F. G. Tatnall of the Baldwin Locomotive Works, Philadelphia, Pennsylvania, who spoke on "Strain Gages." Mr. Tatnall's humor, as well as his complete knowledge of the subject, made the talk delightful and instructive. He outlined the important milestones along the road to the development of the SR-4 strain gage, and explained the various applications of such gages today in studying stresses in structures, aircraft, ships, railway tracks, cranes, machines, etc.

The opening gun of the March 10th meeting was a short pep talk by Ken Mead, Section Director, on the advantages of belonging to the ISA. The main speaker of the evening, introduced by Program Chairman Wade Allen, was Dr. Howard C. Hardy of Armour Research Foundation, Chicago, who spoke on "Sound and Vibration Measurements."

Following an opening discussion of the characteristics of various types of sound, as well as the characteristics of the human ear, Dr. Hardy described with the aid of slides several instruments for measuring and analyzing sound and vibration.

The discussion period was very interesting and covered such topics as the bat's "radar" system, how the deaf can see sound and learn to talk by watching the designs on a screen, etc. —R. J. SCHOFIELD, *Corr.*

WASHINGTON

Since everything these days is super, hyper or ultra, the subject of the February meeting of the Washington Section was quite in line—"The Supersonic Reflectoscope." In brief, the Supersonic Reflectoscope is an instrument for exploring the interior of materials by transmitting into them a short burst of high frequency sound and then listening to the echoes. The magnitude of the echoes and the elapsed time

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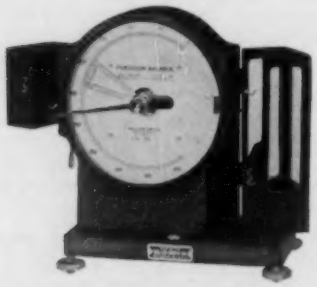

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between the echoes and the original signal furnish information regarding the internal structure of the material. Flaws and other conditions of the material may thus be determined.

Dr. Floyd A. Firestone, Consulting Physicist in Washington, provided an excellent presentation of the subject—in fact, one of the best presentations the Washington Section has been privileged to hear. He is highly recommended to any other Section which is looking for a good speaker and wants to be brought up to date on supersonics.

Fish and chips was in order at the pre-meeting dinner which was served at O'Donnell's Seafood Restaurant in place of the usual Hotel Harrington. Washington's postscript of the month to those would-be members is "For Instrumentation Orientation, Let ISA Be Your Guide."

—R. E. HADADY, *Corr.*

WAYNE COUNTY

The March meeting was held March 15th in St. John's Evangelical Church Hall. Some minor items of business were discussed and next month's election was announced. It was also announced that Bill Baker, the founder and first president of the Wayne County Section, was soon to leave to take a new job in Tennessee.

Mr. Thackara of the Mason-Neilan Company was the speaker of the evening. His subject was "Level Control." With the aid of slides, he showed various installations of float and displacement type controllers, explaining torque tube action, and showing proportional and reset units and pneumatic remote transmission. Problems involving viscous and gaseous liquids were discussed, and several interface level jobs were illustrated and described.

A model of a new valve positioner was also displayed and discussed.

—JOHN MACPHERSON, *Corr.*

Manufacturers' New Literature

In this department we report new literature pertaining to Instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on Page 379.

P-185 **Electronic Micrometer.** 4-page 8½" × 11" bulletin pictures and describes maker's micrometer which "provides the largest linear range of minus or plus .0005" or minus or plus .005". The Graham-Mintel Instrument Co., 2443 Prospect Ave., Cleveland 15, Ohio.

P-186 **Electronic Circuit Panel.** 2-page 8½" × 11" bulletin explains and illustrates the circuit panel which contains three octal tube sockets and 18 binding posts mounted on a panel. Kepco Laboratories, Inc., Electronic Instruments, 142-45 Roosevelt Ave., Flushing, N. Y.

P-187 **Signal Generator.** 1-page 5" × 6⅛" data sheet announces maker's "Pocketracer," an R.F. and audio signal source of the multivibrator type for quick analysis of circuit difficulties. Radex Corp., 2076 Elston Ave., Chicago, Ill.

P-188 **Signal Calibrator.** 2-page 8½" × 11" bulletin introduces maker's "Electro-Cal," instrument which covers 0 to 1000 millivolts in 8 continuously variable ranges; 0-5 volts covered in one continuously variable range. Industrial Electronics, Inc., 21 Henry St., Detroit 1, Mich.

P-189 **Multiple Power Supply.** 2-page 8½" × 11" bulletin pictures and describes "Model 103" multiple power supply developed to satisfy the need for a source of power that would supply four commonly used voltages from a single compact unit. Kepco Laboratories, Inc., 142-45 Roosevelt Ave., Flushing, N. Y.

P-190 **Remote Torque Control System.** 8-page 8½" × 11" Bulletin 711-21 charts and explains company's remote torque control system which can be supplied to operate from either single-phase, 115-volt, 400-cycle power or from single-phase, 110-volt, 60-cycle power. Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.

P-191 **"Wheelco Comments."** 4-page 8½" × 11" Vol. 7, No. 2 issue of this house organ features an article on "Remodeled U.S. Rubber Boiler Room Features Wheelco Flame-otrols." Wheelco Instruments Co., Wheelco Bldg., Harrison and Peoria Sts., Chicago 7, Ill.

P-192 **Stainless Steel Vacuum Flasks.** 6-page 3¾" × 8½" folder describes "Dewar" flasks with these features: unbreakable, explosion-proof, built-in radiation shield, repairable if damaged, etc. Scientific Glass Apparatus Co., Inc., 49 Ackerman St., Bloomfield, N. J.

P-193 **New Signal Generator.** 4-page 8½" × 11" Bulletin 132 gives complete information on four new units: Model 720 FM Signal Generator, Servisher Model 8073, Servicette, Models 4410, 4420, 4712 and the Modernization Unit for tube testers. Radio City Products Co., Inc., 152 W. 25th St., New York 1, N. Y.

P-194 **Liquid Level Controls.** 4-page 8½" × 11" bulletin presents the principle and operation of maker's induction relays, induction relay switches, relay enclosures, starter and relay combinations, etc. B/W Controller Corp., 2200 E. Maple Rd., Birmingham, Mich.

P-195 **Thermocouple Wire.** 24-page 8½" × 11" Bulletin GEA-4881 lists the complete new line of high-accuracy thermocouple wire for measurement of temperatures in industrial processes and laboratories. General Electric, Apparatus Department, Schenectady, N. Y.

P-196 **Internal Comparators.** 16-page 8½" × 11" Circular No. 499 pictures and describes "Electrolimit" instruments designed to gage the internal diameters of parts. Pratt & Whitney, Div., Niles-Bement-Pond Co., West Hartford 1, Conn.

P-197 **Insulation Tester.** 4-page 8½" × 11" Bulletin No. 441 announces "4 in 1" megohmer, a combined insulation tester, ohmmeter, ac voltmeter, dc voltmeter. Herman H. Sticht Co., Inc., 27 Park Place, New York, N. Y.

P-198 **Miniature Speed Changers.** 4-page 8½" × 11" Bulletin No. 100 gives complete information on miniature speed changers for instruments, controls, regulators or any small power devices. Metron Instrument Co., 432 Lincoln St., Denver 9, Colorado.

P-199 **Relays and Electrical Timing Devices.** 24-page 8½" × 11" Catalog No. 148 completely indexes companys' heavy, medium and light duty relays, plate circuit relays, special relays, etc., available. Potter & Brumfield Sales Co., 549 W. Washington Blvd., Chicago 6, Ill.

P-200 **100-volt 60-cycle Amplifier.** 4-page 8½" × 11" folder pictures and describes "Type 143 LA Microsen" amplifier. Manning, Maxwell & Moore, Bridgeport 2, Conn.

P-201 **"Cenco News Chats."** 20-page No. 59 Spring 1948 issue of this house organ contains articles on Luther Burbank, refraction of gases, ball and socket joints, etc. Central Scientific Co., 1700 Irving Park Rd., Chicago 13, Ill.